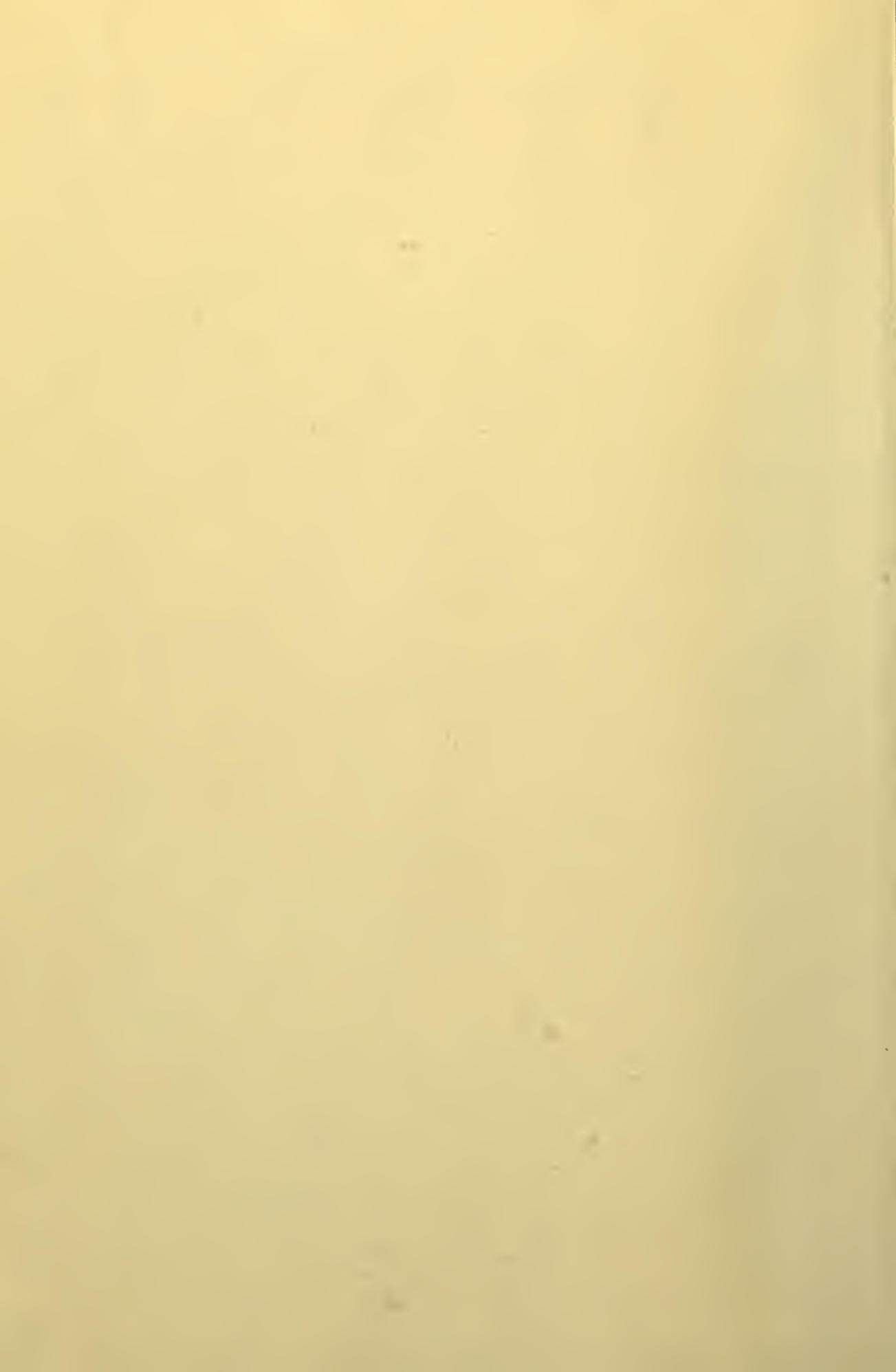






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THE

ENGINEERING MAGAZINE

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AN INDUSTRIAL REVIEW

VOLUME XVII

April to September, 1899

NEW YORK

THE ENGINEERING MAGAZINE

1899

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NO. 1.

THE MONITOR, THE BATTLE-SHIP, THE CRUISER,
AND THE DESTROYER.

By G. W. Dickie.

THE subject of this article is not of my own choosing. When the editor steered this fleet into my harbor he asked me to look at the vessels and give my opinion of their usefulness, as types of fighting ships. He asked me to consider whether the Spanish-American war suggested any modifications of these types or the further consideration of European practice and late designs. He also asked me to compare the types as to functions, sphere of action, and relative efficiency, and to examine the matter of their apportionment, as to number and service, in a naval establishment.

In attempting to comply with this request, I must, at the outset, acknowledge that, although I have had a little experience in the building of each type of war-ship represented in the title of this article, I am by no means qualified to write with authority on the qualities most to be desired in these various types of war-ships, especially within the limits here set. I must therefore confine myself to the expression of my own opinion in regard to the designs at present accepted for these various types of fighting vessels; and this I purpose doing from the engineer's and shipbuilder's point of view. These types I will consider in the order given.

THE MONITOR—This type of war vessel is not the result of development from simpler forms that suggested the direction of improvements; it is an invention that embodied at first all the principles that characterize the type to-day; it was born of necessity, and has held a place in the United States navy since its advent, because of the good work done by the first vessels of the class.

THE BATTLE-SHIP AND THE MONITOR.

The United States navy, however, is the only one that has a class of vessels that can be called monitors. While this type was the direct cause of many modifications in the hulls and batteries of the battle-ships in the navies of Europe, in no case was it adopted as a type. The very low freeboard and light draught of the monitor did not appeal to the British and French naval constructors as qualities worth the sacrificing of so many desirable qualities; so they took from the monitor some of its peculiar features, and worked them into their own designs in such a way as to completely hide the type. It is only when we take these designs apart that we find the monitor embodied in the very center of their structure.

Take the British war-ship Dreadnought, and remove the upper deck and sides, forward and aft, to the berth deck, and you have practically the double-turreted monitor left, with the superstructure armored, and the draught of water greater than the monitor's.



A HIGH-FREEBOARD FRENCH BATTLE-SHIP—THE MASSÉNA.

11,924 tons, 13,500 i.h.p., 17 knots; 347.6 x 66.3 x 26.3 feet; 2 12-inch guns in separate turrets fore and aft; 2 10.6-inch in separate turrets on the beam; 8 5.46-inch quick fire; 8 3.9-inch quick fire; 12 3-pdr., 8 1-pdr., and 4 1-pdr. quick fire.

The French ships Tréhouart and Bouvines may be regarded as modified monitors, but these ships have had a superstructure added forward, to improve their sea-going qualities, since they went into commission.

The monitor, therefore, as a distinctive type, not only originated

in America, but is found nowhere else. In the country of its origin it holds a high place in popular estimation, and could not be abandoned by American naval authorities without reasons strong enough to convince congress.

Amongst American naval officers, and especially among those



H. M. S. DREADNOUGHT.

10 820 tons, 6,500 i.h.p., 13.5 knots; 320 x 63 10 x 26.9 feet; 4 12.5-inch guns, in pairs, in turrets; 6 6-pdr. and 12 3-pdr. quick fire; 7 machine guns; 2 torpedo tubes to be fitted.

who have commanded or served on monitors, this type is considered a very important factor in the navy. Some of these officers claim for it that it has a more extended sphere of usefulness than has been assigned it by its designers. There is no doubt that monitors have frequently performed duties for which they were not intended, and have succeeded to a certain extent in performing these duties satisfactorily. For instance, there were several monitors in the seagoing fleet under Admiral Sampson, and the Monterey and Monadnock were sent from San Francisco to Manila; yet the monitor type would never be designed and built for such service. Admiral Sampson did not consider his fleet very much improved by the presence of the monitors, and the Monterey and Monadnock reached Admiral Dewey only by being towed most of the way.

The monitor is essentially a harbor-defence vessel, and its great advantage lies in the fact that so little of the vessel is out of water, making armor protection possible and effective, with little weight, and enabling a heavy battery to be carried on a comparatively small displacement, which means small dimensions and light draught. All



U. S. MONITOR MONTEREY.

4,138 tons, 5,072 h. p., 14.4 knots; 256 x 59 x 14.9 feet; 2 12-inch guns in fore barbette, 2 10-inch in aft barbette; 6 6-pdr. and 4 1-pdr quick fire; 2 Gatlings.

these qualities are very good, and if they were accompanied by others necessary in a sea-going vessel, the monitor would have a wider range of action than can now be accorded it.

The small amount of exposed hull means a low freeboard. This renders speed practically unattainable. The Monterey, with 4,000 tons' displacement, has, say, 30 inches' freeboard; draught of water, 14 feet. In smooth water, at $10\frac{1}{2}$ knots, the wave comes over the bow. At full power, 5,200 horse, the depth of water above the stem is about 7 feet, and at the forward barbette the water is 18 inches deep on deck. Speed therefore is out of the question. The small dimensions and shallow draught, coupled with the small range possible between normal and load water lines, renders large coal-capacity impossible. Hence the radius of action is limited to a small circle.

The main battery, being carried so near the water-line, can be used only in practically smooth water. In short, the monitor is an ideal harbor-defence vessel, and should not be expected to perform sea-service, for which her design is entirely unsuited.

Since the monitor was invented, the enemy it must meet has become a far more powerful fighting machine than that against which it was originally pitted so effectively. The monitor cannot get so close to the enemy now as before; owing to its slow speed, it must

be more on the defensive, and should be fitted accordingly. Besides its big guns, of which it should always have four in two turrets,—all alike, so as to have all the ammunition available,—it should have a large secondary battery of quick-firing guns for defence against torpedo attack, to which a monitor is peculiarly subject.

The four monitors of the Arkansas class, just ordered by the United States government, do not meet expectations as to the main battery, although provided with an excellent secondary battery.

In a fight with a faster ship of equal maneuvering power, the single turret could be kept masked by the superstructure.

In my opinion, if a single-turreted monitor is built, it should have an all-round train for the turret, all living quarters being under the main deck. In this case the secondary battery could be installed on a platform above the turret, which should be made large enough to mount four 8-inch quick-firing guns, with a small independent train. The platform would have hammock berthing all round, with, say, two 4-inch guns and six 6-pounders.

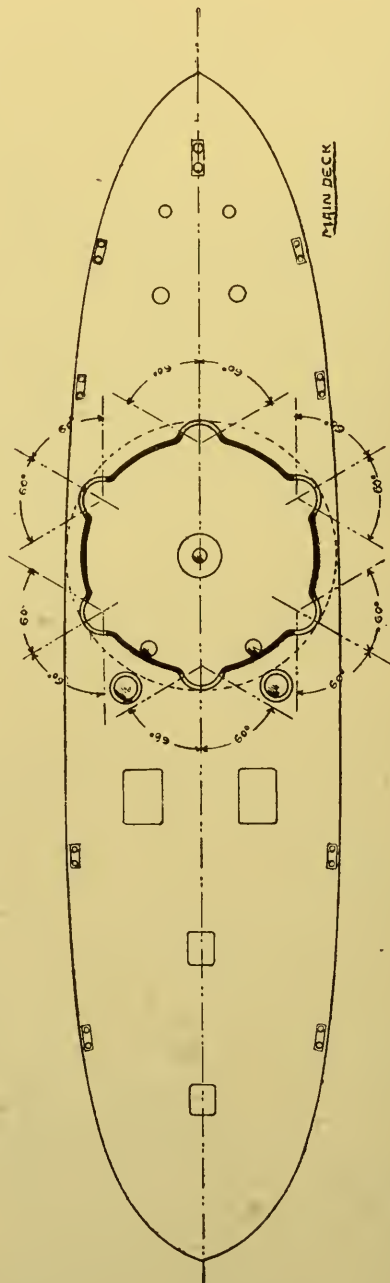
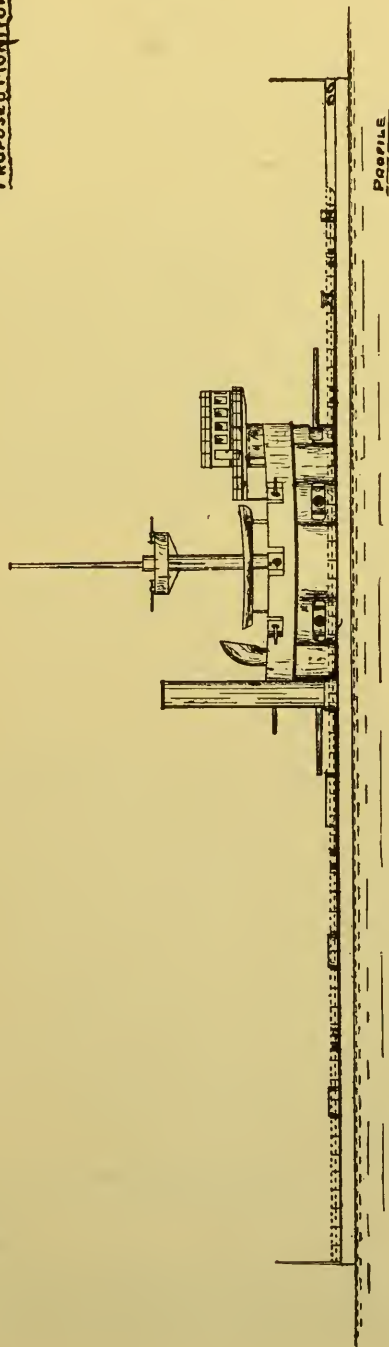
At this point the question naturally occurs to a designer: Why have a revolving turret at all, with its intricate and delicate mechanism, that admits of fighting from only one side, when a circular redoubt,



U. S. S. OREGON.

10 231 tons, 9,500 h.p., 17.5 knots; 348 x 69.3 x 24 feet; 4 13-inch guns, in pairs, in turrets;
8 8-inch, in pairs, in turrets, 2 on each beam; 4 6-inch quick fire in sponsons; 20 6-pdr.
and 6 1-pdr. quick fire; 4 Gatlings; 7 torpedo tubes.

Proposed Monitor

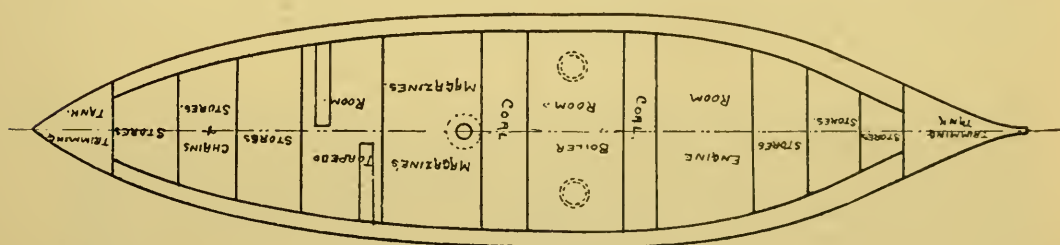


PROPOSED MONITOR. PROFILE AND MAIN-DECK PLAN.

of a diameter nearly equal to the beam of the vessel, would enable at least two guns to be directed on one object, while at the same time other guns could be turned on other objects, and the superstructure would be a fixed platform, enabling each gun to be worked independently.

On these lines I have worked out a scheme that enables a battery of six 8-inch quick-firing guns to be effectively mounted, the barbette being 50 feet in diameter, and the upper platform 58 feet, which gives room for ten 6-pounders. The magazines would be located forward of the coal bunkers, the ammunition being served by endless chains worked by electric motors. The arrangement would be somewhat similar to that shown in the sketch plans (Figs. 1, 2 and 3). In such a vessel the danger of damage to the turret-turning gear is eliminated, and each gun is independent of its neighbor.

A vessel having the revolving turret as its distinctive feature, while coming under the class or type to which the monitor belongs, would hardly be accepted in the United States as a monitor. Yet, I think, if the type is to be retained it will undergo some such modification.

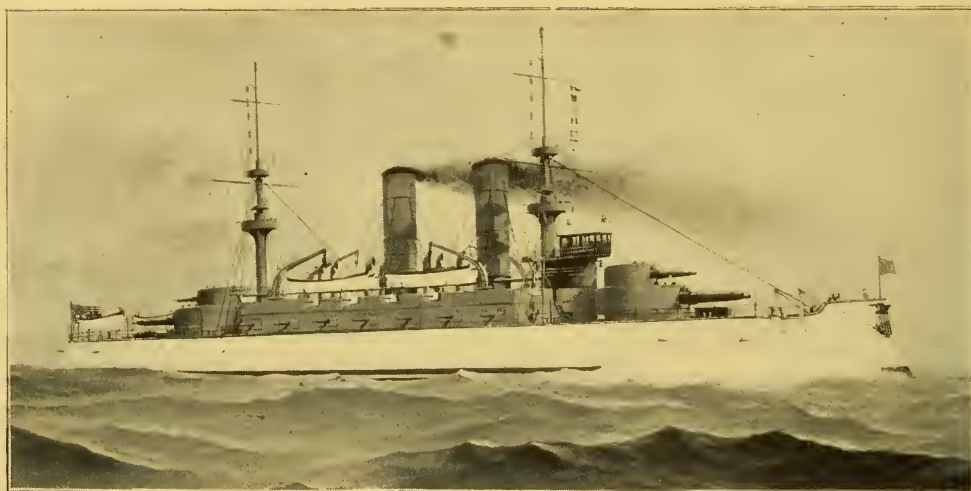


PROPOSED MONITOR. HOLD PLAN.

As the natural weapon for attack on the monitor is the torpedo, I have thought it strange that the monitor has not been fitted with means of defence against this attack, or with any means of returning it. There is no difficulty in fitting a monitor with submerged torpedo tubes, and it appears to me that, in its special function of harbor and coast defence, it would have more and better opportunities to use them than battle-ships or cruisers would have. I therefore show two submerged torpedo tubes fitted directly on the inner bottom forward of the magazines. The center line of these tubes would be about nine feet below the surface of the water ; although not quite as deep as such tubes are in battle-ships, they are certainly within the limits of effective working, and would be a great addition to the monitor's offensive power.

I have already devoted more space to the monitor than its comparative importance warrants. Yet, if it is possible to preserve the

THE BATTLE-SHIP AND THE MONITOR.



U. S. S. KENTUCKY.

11,500 tons, 10,000 h.p., 16 knots. Dimensions practically the same as the Illinois. 4 13-inch and 4 8-inch guns, in pairs, in superposed turrets; 14 5-inch quick fire; 20 6-pdr. and 6 1-pdr. quick fire; 4 machine guns; 5 torpedo tubes.

good qualities that undoubtedly belong to the monitor, and to add other qualities that will enable it to act as a coast-defence vessel, where voyages of considerable duration must be made at sea,—sometimes a



U. S. S. ILLINOIS.

11,525 tons, 10,000 h.p., 16 knots; 368 x 72 x 23.6 feet; 4 13-inch guns, in pairs, in turrets; 14 6-inch quick fire; 17 6-pdr., 6 1-pdr. quick fire; 4 machine guns; 4 torpedo tubes.

necessity, especially on the western coast of the United States,—such a type of vessel will be able to do work that now requires a battle-ship or armored cruiser.

At the same time, it must be admitted that the battle-ship or armored cruiser can accomplish much that the monitor cannot, and this fact will limit the application of the monitor type, no matter how modified, to harbor and coast defence, its principal limitations being the extremely low freeboard which limits the speed, and the small coal-capacity.

BATTLE-SHIPS.—This type of vessel in its various modifications, notwithstanding the many predictions that new instruments of attack would render it worse than useless, is still the backbone of all the great navies of the world.

The most noticeable thing at the present time is the narrowing of the difference between the battle-ship and the armored cruiser. The latter, in some cases, now equals the largest battle-ship in displacement, while the latest battle-ships have very nearly the speed of the fastest armored cruisers. The marked increase lately effected in the resistance of armor has enabled the battle-ship designer to decrease the thickness of armor, and spread it over a much larger area. Consequently, the battle-ship has increased in length and in fineness, and with these qualities speeds hitherto thought impossible are now obtained with certainty on the new ships of this class. This advance has been so marked that there appears to be little or no room left for a distinct type of armored cruiser readily distinguishable from the battle-ship.

At present the United States have four first-class battle-ships in commission, and eight in course of construction. The first three, the *Indiana*, *Massachusetts*, and *Oregon*, may be termed low-freeboard battle-ships, as there is no structure above the main deck at the ends, the superstructure extending only between the main turrets.

These ships carry a very heavy main battery, consisting of four 13-inch, eight 8-inch, and four 6-inch guns. Their low freeboard has been commented on as unfitting them for ocean service; yet the *Oregon* has proved that these ships are not deficient in sea-going qualities. Though they are not as fast as the latest types of this class, the *Oregon*, built as a 15-knot ship, can respond at any time to an order for 16 knots.

The main turrets of the *Oregon* are operated by hydraulic power, while in her two sister ships the main turrets are operated by steam. I have not been able to obtain any correct data indicating which

power is most to be depended upon in action. The battle-ships have not yet been tested in an equal contest with ships of the same class, and the Spanish-American war, beyond strengthening the opinion that the first and best thing for a great navy is battle-ships of the highest class, added little to our knowledge of their merits and demerits.

The Iowa followed the first three, and in her the effect of criticism is noticeable. The superstructure extends to the bow, and 12-inch guns replace the 13-inch, the forward turret being above the superstructure deck. This was expected to be, and is regarded as, a sea-going battle-ship, and for comfort in the men's quarters it is better than the three first vessels.

The next two, the Kearsarge and Kentucky, differ from the others in having both main turrets on the main deck; but that deck is higher, relative to the water line, than the decks of vessels of the Oregon class. The main belt is carried to the stem; 13-inch guns are again found in the turrets; four 8-inch guns, instead of eight, and the 8-inch turrets are built on the roof of the 13-inch turrets, and train with them. To train together four guns, all of which are dependent on one piece of intricate machinery, is, I think, a mistake.

In the next three, now being built, the Alabama, Illinois, and Wisconsin, the forward turret has again been raised, the superstructure extending to the bow; the 8-inch guns have been left out, and a battery of 6-inch quick-firing guns has been substituted. The belt armor is carried forward to the stem. The contract speed is 16 knots. It is confidently expected, however, that the speed will be about 17 knots, with one inch air-pressure in the fire rooms.

The last three battle-ships for the United States navy, just contracted for, were to have been constructed from the plans of the Alabama class, but the desire for greater speed induced the navy department to invite builders to tender for 18 knots instead of 16, as intended. These ships, therefore, will be twenty feet longer than the Alabama, and will have a power exceeding the Alabama's by about 3,000 horse.

Owing to the light draught of water,—light as compared with that of British battle-ships, $23\frac{1}{2}$ feet normal,—the new United States battle-ships will not have so fine lines, and therefore must have greater power to obtain the speed required. The dimensions fixed upon are: 388 feet long; 72 feet beam; draught of water at 12,500 tons displacement, $23\frac{1}{2}$ feet $8\frac{1}{2}$ inches. They will be the first of the United States ships to have submerged torpedo tubes. They are to

carry one thousand tons of coal on their normal displacement, and have bunker capacity for two thousand tons.

As a result of experience gained during the late war, wood is to be used as little as possible, and, where used, it is to be subjected to the treatment known as the electric fire-proofing process. There is no doubt that the substitution of light corrugated steel for wood in all partitions and bulkheads in living quarters gives to these rooms a prison-like appearance that is anything but comfortable. But the need of a better material for this purpose will in time produce it. Boards made from pulp that is thoroughly fire-proofed and stamped into artistic shape will, no doubt, soon take the place of corrugated-steel plate, and fire-proof rooms be as attractive as those of wood.

The most needed improvement on war-ships at present is simpler mechanism for all purposes that require power. Since I have had to do with the getting out of machinery adapted to the many and varied requirements on these vessels, I have never missed an opportunity to advocate greater simplicity and directness in applying the power to the work to be done. Shipbuilding and naval traditions are the strongest obstacles to be overcome in attempts to improve in the direction of simplicity. The war-ship is a growth, and, while new methods are invented for certain purposes and adopted, the old methods are still retained, until in some ships we find several ways of doing the same thing, all adding to the general complication.

The firm with which I am connected is just finishing a war-ship for the Japanese navy. It is lighted by electricity. The generators are in triplicate, to insure against failure, and the wiring is divided into several circuits, so that only a portion of the lights would be extinguished in case of failure in transmission. Yet, after all that care, oil-lamps must be fitted wherever light is required, and, lest there should be no oil in the lamps, three hundred candle-sticks must be furnished.

While this question of simplicity is a general one, and applies to all classes of naval ships, yet I may state here in what way I would simplify battle-ship operations requiring power.

Owing to the divided responsibility in the construction of war-ships, the design partakes largely of the methods favored by the various bureaus that control certain parts of the work, and therefore a homogeneous whole cannot be expected.

In the important matter of power-transmission I do not know of a single ship in which one mode of transmission has been adopted throughout the ship. Steam pipes, water pipes, and electric wires are

still run side by side from end to end of the ship, where one would answer all purposes. While I have been a strong advocate of hydraulic power-transmission on war-ships, there are so many operations in which electric transmission seems to meet the conditions more directly that I now think we are fast reaching a stage of development in the application of this subtle agent, which will render it the best means by which to operate all mechanism requiring power on board war-ships. The use of only one means of transmitting power on a given ship would be a great step in the direction of simplicity.

In nature we find that living organisms, when they have no further use for an organ that played an important part in the life of their ancestors, have the means of suppressing, or blotting out, as it were, the useless organ. But shipbuilders carry along a lot of appendages hardly ever used at the present day. The old sailing ship of the line required an efficient system of hand, fire, and bilge pumps, so arranged that men could work at them. Now we have an elaborate system of steam pumps for drainage and fire purposes, and yet the old hand pumps are fitted with their long cranks and many valves and connections to manifolds, although never used except in tests of their condition.

The whole drainage system on these ships has been a growth, and, in consequence, needs to be freed from the many appendages that have outlived their usefulness. I see no reason why a main drain should not be provided in the construction of the hull, by having two vertical keel plates instead of one, the space between being the main drain well, extending from end to end of the ship. All compartments would drain into this well through valves controlled from the deck, and the pumps would draw directly from it.

Another complication is ventilation and heating. These matters, in the United States navy, are under separate bureaus, the ventilation coming under the head of construction, and the heating under that of engineering. The heating system is a source of great trouble. The large amount of piping and the many fittings render it very difficult to prevent leaks. Now, with artificial ventilation as carried out for all living spaces on war-ships, it would be a very simple thing to have each ventilating fan or blower deliver through a heater box fitted with the proper amount of steam-pipe surface, thus heating the fresh air to be sent through the living spaces, instead of running the hot steam pipes all over the ship.

Where new methods of operating are adopted, they should always be reliable enough to displace the old methods, instead of being added

to them, as usual. I have never seen a telemeter, for instance, applied to operating the valve mechanism of a steering gear, that replaced the appliances already in use for the same purpose.

In the engineering department the same duplication of methods for accomplishing a given purpose prevails. The only thing remaining for which but one method of operating is provided is that of turning the propeller, which has come to be apparently of less importance than the question of how to handle feed-water pumps, fire pumps, filters, heaters and the numerous accessories pertaining to what used to be considered secondary matters.

If the whole auxiliary system were blotted out and a fresh start made with the simple purpose of meeting all requirements as simply and directly as possible, much of the present complication could be avoided. There should be a pumping compartment, with the most economical pumping plant in duplicate for feed-water, its function to be that of taking feed-water from the feed tank, and delivering it into a feed main at a pressure sufficiently above the boiler pressure to make the feed absolutely sure. A loaded valve on this pipe would return the surplus to the feed tank. The attendant would regulate the speed of this pumping engine by the flow from the surplus valve. A bilge and fire pumping engine in duplicate would also be in the same compartment. A set of low-pressure pumps would also be required for water service, sanitary service, and circulation in auxiliary condensers and distillers. Main bearings, guides, etc., that have closed water circulation for keeping the parts cool, should discharge into the sanitary tanks overboard. The present plan of having them open to the bilge involves much pumping.

The great mass of pipes, valves, and manifolds, now fitted always in duplicate, and often in quadruplicate, is often more a source of danger than of safety. They are now made with little margin of strength. A small amount of wear or corrosion puts them out of service, and usually the duplicate is in the same condition as the original. If seventy-five per cent. of the material now put in duplicate pipe systems were put in one substantial arrangement, there would be less liability to derangement, and only one-half the stuff to care for. I am satisfied that one-half the piping and valves could be removed from the engine and boiler compartments of our war-ships, in accordance with a plan that would increase their efficiency, reliability, and safety. It only requires that the traditions of the service be laid aside, and a new start made on common-sense principles.

In the change that is taking place in the type of boiler used on

war-ships, the usual conservatism in regard to naval practice has been cast aside; where it was hardly possible with the Scotch boiler for the engineer to obtain space enough to install the boilers as to get the very best result, the water-tube boiler now demands practically the whole ship under the protective deck. The argument in favor of this type of boiler—that it is lighter than the Scotch for a given power (I refer to boilers of the Belleville type)—has been given up for another that may have more foundation in fact,—viz., the possibility of making repairs without opening the decks of the vessels. It has been customary to install Scotch boilers in war-ships without regard to convenience in the matter of repairs. I have seen air shafts built over fire rooms not large enough to permit the passage of a furnace, when an inch or two more would have made the removal of a furnace as easy as on a merchant vessel.

The contention that Scotch boilers would not stand forced draught has been settled by the fact that a large proportion of merchant steamers now use forced draught constantly, making continuous records of more than 20 h. p. per foot of grate, while in war-ships such a record is about the best reached for a trial of a few hours, and it was considered a great success if the boilers were not injured in doing it.

It is not yet time to claim that the water-tube boiler in any of the many form now in use is to be the boiler for war-ships of the future. The question of endurance under unfavorable conditions has yet to be decided, as also the question of fuel economy.

As it stands to-day, the navy department of the United States stands committed to a trial, on a grand scale, of the water-tube boiler on battle-ships. This will have the effect of lengthening the ships, as a form of water-tube boiler suited for sea service cannot be installed in the space that accommodates the Scotch boiler, while more room must be given to evaporators for the production of fresh water, and more again to storage of the water thus produced. Skill that may be acquired in the management of water-tube boilers may reduce the work for evaporators, and thus save fuel used for that purpose.

The small amount of water in the boilers to take up and give out heat as the fire temperature varies is the principal cause of difficulty—to be overcome only by the skill and vigilance of those in charge.

That the water-tube boiler has made little progress in the merchant service, where economy in fuel and in operating expenses is more closely watched than in the navy, need not be taken as an argument against its use in the navy, there being other factors than expense that may outweigh all economic considerations.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

IV.—COMMERCIAL ORGANIZATION AND SALES MANAGEMENT.

THE commercial management of a machine shop is so closely connected with its mechanical success, or failure, that a consideration of this side of the question is necessary for an appreciation of the relative conditions of European and American machine-tool work. The peculiar condition of the European market is of special interest to European makers who are endeavouring to keep abreast with the times, and to American makers, many of whom have recently enlarged their works solely on the strength of their increasing foreign trade. American and European methods differ as widely commercially as they do mechanically. It is my object to contrast some of these, as well as to outline briefly the situation with reference to the European market for machine tools.

In the machine-tool business, as in others, a successful commercial policy must harmonize with economic demands and the industrial situation. Economy demands specialization of plant and concentration of ability, which must be devoted to production in a particular line. The industrial situation is such that the days of cheap machinery (that is, machinery of really bad quality and primitive design) are numbered. As the "machine-made" takes the place of the "hand-made" article, machinery must become capable of turning out a more highly-finished and perfect product; this cannot be done by cheap machinery. The commercial policy of the modern machine shop, then, must be dictated mainly by two conditions,—specialization and good quality. With few exceptions, American manufacturers recognize specialization as an absolute necessity to commercial success; it is also adhered to by many European manufacturers, but, as makers of machine tools, it is not adopted by them in a single instance, though they recognize it as an essential to success in nearly every business but their own. The size of the machine that most European makers will undertake to build seems to be limited only by the height and width of their workshops, and the variety only by their ability to get orders. There is, relatively, far more cheap machinery made in Europe than in America. Most American manufacturers will take

orders for only such machinery as they are specially fitted, by experience and equipment, to make. This principle is the keynote of their success in the European market. It is strictly adhered to by those who are at the front, it is not followed by those who are, admittedly, dropping behind, and it must be, sooner or later, adopted by all.

The commercial advantages possessed by the specialists, in comparison with the makers of varieties, are many. First and foremost is the fact that they can, almost invariably, offer a machine that will pay their customers far more interest on the investment than the makers of varieties can show. Devoting themselves to only one line, they can always lead in the production of machinery that will save labour, do good work, and be well made. As the whole energies of their staff, and their entire factory equipment, are devoted to the production of one article, they can always sell for the lowest price, and, as they usually make in quantities for stock, quick deliveries can be made. Known as specialists, they are frequently, and preferably, sought by purchasers. Having had, within the last few years, a great deal to do with the ordering of large quantities of machinery, I have found the maker of specialties invaluable as a consulting engineer, with reference not only to his own product, but also to the products of makers in other lines. My experience has been the opposite with makers of large varieties, from whom comparatively little can be learnt which does not pertain strictly to their own work. The commercial success of the American specialist in Europe is already assured; he can meet competitors in every respect, and can offer machinery that turns out a greater product, cheaper, better made, and more quickly delivered, than the European maker usually produces.

In America competitive specialization has, undoubtedly, assisted largely in developing many of the handy movements and labour-saving devices which are common to the American machines, but, as a rule, lacking in the European article. Other important commercial advantages are connected with the American system of specializing; manufacturing is simplified, office expenses are lower, and exact cost-keeping is easily carried out. All of these assist to produce an article which, in price and quality, defies competition on the part of makers of large varieties. Machines are made for stock, not to order. Some makers even store machines in boxes ready for shipment. It is one of the vexations of the machine-tool business that customers put off ordering until the last minute. Having once decided, however, time of delivery often determines where the order is to be placed. Even machines of special dimensions—like lathes of extra length—

can be delivered in from two to three weeks, as makers who are devoting themselves to a single line keep in stock a large number of standard parts, such as headstocks, tailstocks, and carriages, so that the order for a special length of bed merely means casting and finishing the bed itself. As far as I have seen, this method is carried out in only a few instances by European makers of machinery, and then in but a comparatively small way.

In their methods of securing business, the American manufacturers of machinery have as little veneration for time-worn customs as respect for old-fashioned machinery. The best of them advertise their wares in the leading technical journals in a manner which many European machine-tool makers would not think it possible to adopt without sacrifice of their so-called "respectability." The fetich, "professional etiquette," which still so largely influences the conservative European manufacturer, does not exist to the maker of machinery on the western shore of the Atlantic. The American never sits at home, waiting for orders to come to him. Unlike many European makers of machinery, he has no clientele to stick to him, regardless of improved designs and quicker-acting machinery developed by others. He takes the fullest advantage of all avenues open for advertising his machinery, and for bringing it before the public. His representatives are usually practical men who have had shop experience, and can intelligently advise as to the application of new methods. Mention has already been made of the manner in which the American manufacturer uses the machine-tool maker as a consulting engineer.

On the other hand, I find it a complaint, among large European buyers of American machinery, that the European maker takes little trouble to bring the merits of his goods before purchasers, or to employ suitable men, trained as engineers, to deal with customers. The qualifications which the American machine-tool maker possesses are highly appreciated by European purchasers. Usually sticking to one line, he has no object whatever in concealing any knowledge he may have respecting other makers, and he will generally freely advise as to machinery made by others. Specialization works commercially, as well as mechanically, to the advantage of all concerned.

Speaking of specialties, I am reminded of one that is peculiarly European; I mean "tipping." The American machine-tool maker is free to secure business on the merits of his goods, rather than on the commissions which he can offer to foremen and works managers. But the extent to which "tipping" is carried on among European manufacturers is, I think, a serious drawback to all concerned.

The success of a machine tool of ordinary or special design is too often dependent upon the commission secured by the foreman, or upon the liberality with which Christmas boxes are distributed. This latter is a form of bribery accepted to a surprising extent.

Although there are exceptional cases on both sides, it may be said that American managers and proprietors of machine shops are harder working, more practically trained, and more thorough masters of details than men in the same positions in European establishments. Many of the best European machine shops are governed by thorough engineers. In some cases where they admit points of superiority in American practice, they do not adopt them for the reason that manufacturers and workmen still demand out-of-date designs and old-fashioned appliances. Moreover, English machine-tool practice is largely influenced by government stipulations, which are rarely "up to date," and by a large foreign trade which, up to the present, has been encroached upon to a comparatively small extent by other nationalities. The American manager works longer, and thinks less of his holidays, than the European. The shooting season and the watering place interfere but little with his business application. I am acquainted with a number of managers of American machine shops of wide reputation who can be found in the works every morning at seven o'clock. They are closely in touch with their foremen and workmen, and associate with them on a more friendly and familiar basis than is possible in a European shop. With few exceptions, the managers of the leading machine-tool works of the United States are successful mechanics and at the same time good business men. This would hardly be true, as a general statement, with reference to European machine-shop managers.

The management of technical affairs by commercial directors who have little or no knowledge of the business they control is of rare occurrence among American manufacturers, although there are several well-known exceptions in the United States among makers of machinery. Every engineer who has attempted to work under management of this kind must realize the great disadvantage under which such companies work, in comparison with corporations conducted by thoroughly practical men. The military systems of continental Europe have developed a peculiar mania for bureaucratic management in manufacturing establishments. This is a curious fact, as European armies are striking examples of what can be accomplished by the combination of the theoretical and practical. In the army, however, command must be in the hands of those who

are thoroughly trained in every detail of the profession, and have had experience in every department. In Germany mechanical development is, in many cases, largely directed by technically-trained men, who are crammed with book knowledge, but have little or no practical experience. The conditions under which American machinery has been developed, and against which they must compete, these men little understand. To this ignorance on the part of so-called commercial and technical directors, which is so prevalent in Germany, is the inefficiency of the labour which they control largely due. German workmen are capable of doing the finest mechanical work. Americans are still sending to Germany for the best optical and microscopic instruments, for the most delicate levels and accurate graduating. Capability is not wanting, but the large body of mechanical workers is spoiled by mismanagement and bad supervision. Incompetent technical superintendents hold positions, secured through influence by commercial directors who have no knowledge of mechanical requirements or of the industrial situation, and have, moreover, no appreciation of practical results, good, bad, or indifferent. The result is that generally a low standard exists as regards the quality of manufactured articles, and, as it is considered a correct commercial principle that low wages are the cheapest, high-grade workmanship is not rewarded and consequently not developed.

As far as economic conditions are concerned, the American proprietor has no better understanding of the problem than the European,—probably not as good,—but, from a business standpoint, the American knows the value in dollars and cents of the high-wage-earning, thoroughly-trained mechanic. The machine-tool business is almost wholly controlled by those who appreciate high-grade work and proper organization. This is also partly true of England, whose standard of workmanship is below the American, but above the German. The situation in Germany is peculiar, as the present industrial activity is largely promoted by wealthy banking houses, which, without thoroughly understanding the industrial problem, know that there is a demand for a certain article, and that by investing so much capital such and such dividends are possible. Vast sums are available for founding new factories built by those whose sole occupation is the amassing of money and investing for clients. Such men, whether German, American, or of any other nationality, have little comprehension of engineering requirements or appreciation of engineering ability. Engineering talent is looked upon by them as any other commodity which can be bought for a certain price. Com-

mmercial engineering is, however, more commonly understood in America than in Europe; that is, the advice of engineers in commercial matters is more frequently sought and followed there.

The low standard of workmanship common in Germany promotes the cultivation of peculiar commercial principles. In manufacturing the tendency is to make use of the lowest-paid labour that can be secured; in selling, to dispose of product without sufficiently considering the buyer's requirements, or appreciating the commercial advantages of being in a position to assist him in solving his problems. In America, where the standard of workmanship is high, the opposite conditions are bound to follow. The employment of skilful and highly-efficient labour is necessary. Resort to machine operations, in order to reduce cost of production, is imperative. Reliance on success, and growth of business, are naturally dependent on the reputation made through supplying a superior article. It is a matter of ordinary comment on the part of American manufacturers familiar with German business that they cannot understand how it is possible that so many factories, having out-of-date equipments and employing a low grade of labour, can exist in Germany. Although Germany has many wide-awake, up-to-date manufacturers, she, as a nation, has yet to meet, both in her domestic and foreign trade, the competition of other countries, of whose capabilities she has little comprehension. Capital is not wanting to do this. The progress she is now making in manufacture is evidence of great enterprise. Ability is there. The first essential to Germany's general industrial progress, however, is that she realize her weaknesses, one of the most serious of which is the position which her practical engineers and mechanics occupy, as distinguished from that held by her commercial and scientific workers. In the industrial world there is one class embracing science and commercial management, and another manual labour and executive talent. The two do not fraternize. While there is no brotherly love wasted between workmen and employers in American machine shops, there is, at the same time, practically no social distinction between the bright mechanical worker and the purely scientific or commercial man. There exists an understanding, and an intercourse, which bring the best men to the top in shop management, regardless of educational advantage, or ability to write a scientific treatise or to amass a fortune. The close economical management of works is not carried out in Germany, as it is in America. Actual management is too often directed by those who are appointed to positions of authority on the strength of their supposed commercial

ability, or professional standing, regardless of executive capacity or knowledge of practical details. For the present, this management can succeed in Germany. The demand for material is now excessive, and normal competitive conditions are not yet realized. In many of the newer industries profits are big. As soon, however, as outside competition forces down the price of the article of comparatively better quality, and good work is more commonly procurable, loose technical management must be replaced by a management in which the practical engineer and organization supplant the jobber, professor, and slipshod factory control. English industrial enterprises are, in some respects, in the same condition as German. In the mechanical world, "Hooleyism" is rampant, but it must have a fall. Its disciples know only "dividends." They are enthusiastic over the fantastic inventions of a mechanical crank, and pass by, on the other side, valuable mechanical improvements.

The salesman of a modern machine-tool company must possess other abilities than the mere knack of persuading people to buy. He must be a combination of a consulting engineer and a good business man. He must have had workshop training, as well as drawing-room and office experience. He must be thoroughly in touch with the works which he represents, know its policy, and be familiar with its progress; otherwise he cannot intelligently advise customers. It is well known that one of the largest and most successful of American machine-tool companies employs as salesmen, in nearly every instance, those who have worked in its own shops. Such men are not only valuable advisers to their customers, but are always alive to criticisms of their own work and to improvements which keep their company abreast with the times. It is a weakness of European engineering establishments that the commercial and technical elements have little sympathy with each other. It is a strong point with American makers of machinery that such elements are, in most instances, inseparable. To quote from a recent issue of the "American Machinist:" "a business man may get machinery trade easily enough, but only a mechanic can keep it."

A characteristic peculiar to American makers of machinery is the constant interchange of information, even between sharp competitors. Most manufacturers of machinery are on friendly terms, and I know of several cases where competitors, making the same lines, exchange ideas, and send their workmen to study the methods of their rivals. Shops are usually open to all visitors, and little of that narrow spirit too often shown by European manufacturers exists among American

machine-tool makers. This must, of course, work for the general weal. Improvements in methods of manufacture are quickly adopted by all, and general progress is rapid. It must soon be recognized that it is distinctly against any country or community—or individual, for that matter—to adhere to the principle of closing its factories to anyone. It is a short-sighted policy, and altogether unworthy of an age that prides itself on freedom and progress. An interchange of ideas among those who are working on kindred lines must raise the standard of all. The net result will be a better product, more rapid progress, and, in the end, a larger amount of business.

There is a striking contrast between American machine-shop office management and the sleepy methods in vogue in European factories. No better evidence is necessary to prove the truth of this statement than mention of a few of the office labour-saving devices, all of which have originated in America and are being adopted by many Europeans,—the typewriter, modern letter files, the card index, improved office furniture, time clocks, and recording apparatus. All these save time, simplify methods, and increase accuracy. It would be difficult to find in America a machine shop too small or insignificant to possess a typewriter, a roll-top desk, a swivel office chair, the wooden letter file, and a time-recording apparatus. I have not yet seen the European machine shop office where all the above, every one of which saves time and makes work easier, are in use. The large number of office employees usually connected with the European factory is a matter of comment on the part of Americans. In the office, as in the shop, the same poorly-paid assistants are employed. Low wages, cheap equipments. The dirty and, as a rule, impudent office-lad usually encountered in the English office does not exist in any other country. In Germany clerks, who can be secured in any number for 150 marks per month and, in many cases, can speak and write two or three languages, are commonly employed. The tendency in American machine shops is to make use of highly-developed methods of keeping track of costs, and to have the progress of work supervised by well-paid clerks, and, in many cases, by highly-paid specialists. It is a technical and a commercial necessity to keep exact records of costs and progress of work, by which weak points can be indicated, and wasteful labour spotted. Low costs of production, proper shop organization, and accurate work cannot be accomplished in a factory where office management is out of date, cheap clerks are employed, and old-fashioned methods are in use.

THE MERITS AND PERMANENCY OF THE MASONRY ARCH BRIDGE.

By Albert W. Buel.

WITH the recent tendency toward building more substantial structures has come a renewed interest in that most beautiful class of bridges, the masonry arch. Great progress has marked the art of bridge building since Agrippa built the Pont du Gard 1918 years ago. Spans of 1700 feet already built, and one of more than 3,000 feet to come in the near future, record the advance due to the introduction of steel and refined mathematical analysis. But no bridge of modern times surpasses the Pont du Gard in beauty and grandeur, and it is a safe prediction that it will remain a monument to its builders long after our great modern steel bridges have turned to dust.

The inherent tendency of iron and steel is to return to the condition of ore or oxide from which it was reduced. A piece of steel, unprotected and exposed to the weather, will lose by rust about one quarter of an inch from each surface in one hundred years; or a piece of steel an inch thick will be half eaten away in one century. The present method of protecting metals by paint is so imperfect that it is doubtful whether the best care will succeed in preserving a steel bridge for more than four or five hundred years,—possibly not more than half so long. The average life of iron bridges has been stated to be only forty or fifty years; yet some of the Roman aqueducts have stood for two thousand years, with little or no care.

There are three general types of design under which all bridges may be included,—the girder or truss, the suspension bridge, and the arch. Their distinctive features may be briefly stated. The principal stresses in a girder or truss are both tensile and compressive; in a suspension bridge they are all tensile; in an arch they are all compressive. The direction of the stress exerted by the superstructure on its supports in a girder or truss is vertical; in a suspension bridge it is a pull inclined inward and upward at the anchorages; and in an arch it is a thrust inclined outward and downward on the abutments.

The three classes of material exclusively used in bridge construction are wood, masonry, and iron or steel. On account of the character of the principal stresses, the construction of the main supporting

cables of a suspension bridge is practically limited to iron or steel ; for girders or trusses, wood or metal may be employed ; but an arch may be built of wood, metal, masonry, or any material, or combination of materials, that can resist compression. The arch alone leaves the designer free to choose the most durable material, and, when built of masonry, it stands for beauty and permanence. The girder or truss is temporary in character, and generally ugly. The suspension bridge may be beautiful, but it is not so permanent ; and it is to be regretted that, thirty years after the beautiful Brooklyn Bridge was planned, economical bridge designing should show a result so inferior in aesthetic merit as the design for the new East River Bridge.

The oldest authentic records of bridge construction show the girder type in its most simple form—a beam. The development of the more complex form, the truss, is recent. The only existing examples of suspension bridges are comparatively modern, and the type belongs to the present age. The arch was first used for bridges by the Romans, who brought it to a high state of perfection ; but they seem to have applied the principle to other uses long before they built arch bridges. The Cloaca Maxima, or great sewer of Rome, built about 641 B. C., has three concentric rings of voussoirs, and an internal diameter of about fourteen feet. It is still in a good state of preservation.

The principal styles of masonry arches are the semi-circular, the Gothic or pointed, the segmental, and the elliptical.

The shape of the arch ring in the semi-circular style is half a circle, while in the segmental it is less than half a circle. The ring of an elliptical arch appears like a flattened half-circle, or as if seen from a point above or below the level of the arch. Masonry arches may be built of ring stones (called voussoirs) fitted together, or of concrete forming a “solid arch” of a single stone, called monolithic. The spandrels are the spaces between the arch ring and the roadway, and the haunches are the part of the arch between the crown and the skewbacks. A skewback is the part of the pier or abutment on which the ring rests and from which it springs.

The Roman arches were invariably semi-circular, and were often built of Pozzuolani concrete faced with stone or brick. The illustration of the Roman aqueduct shows the concrete construction very clearly. The Pont du Gard, at Nimes, France, was built about 19 B. C. by M. Agrippa, son-in-law of the Emperor Augustus. It is 873 feet long and 160 feet high, and has three tiers of arches. The span of the arches in the lower piers is 80 feet 5 inches. The width



CLOACA MAXIMA, ROME.

on top is 11 feet 4 inches. In 1743 A. D. the lower tier of arches was widened on one side, as seen in the illustration, to form a roadway.



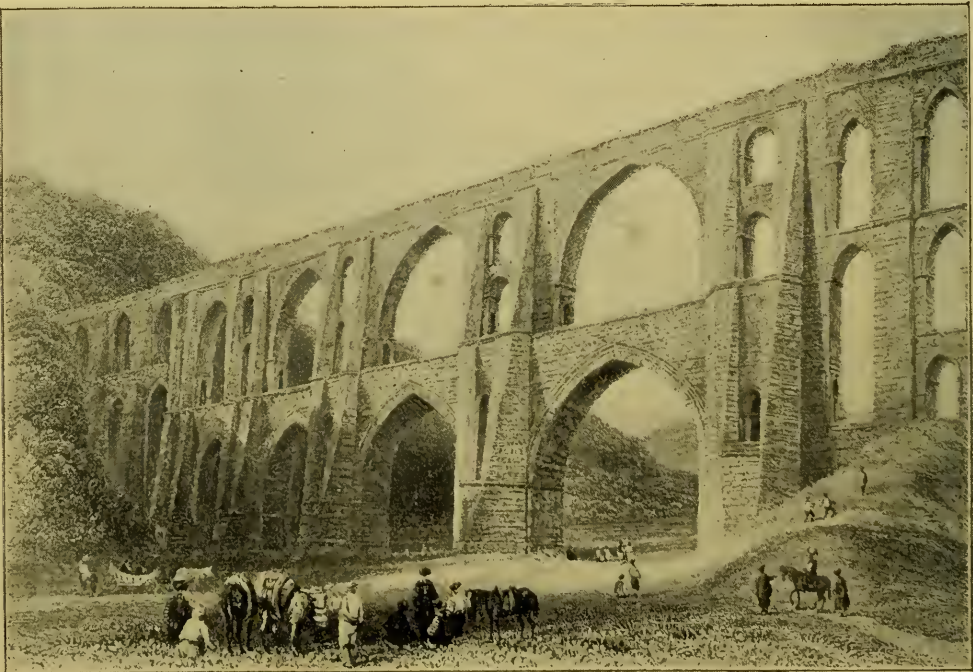
RUINS OF ROMAN AQUELUCT, SHOWING BRICK AND STONE WORK.

THE MASONRY ARCH BRIDGE.



PONT DU GARD, NIMES, FRANCE.

The Aqueduct of Bourgas, near Constantinople, was built in the sixth century A.D., probably during the reign of Justinian. It has a length of 720 feet and a height of 109 feet. The arches of the lower tier have a span of 52 feet, and those of the upper tier 40 feet.



AQUEDUCT OF BOURGAS, NEAR CONSTANTINOPLE.



PONTE DELLA SANTISSIMA TRINITA, FLORENCE, ITALY.

The small arches through the piers tend to relieve the elevation and save material. This is one of the earliest examples of the pointed arch in Europe, the style being taken from the Persians, who probably got it from India. It is poorly adapted to bridge construction, for which it is no longer used.

The Ponte della Santissima Trinita (Holy Trinity Bridge), over



PONT-Y-PRYDD, OVER THE TAFF, WALES



PONT DU CINT, AMIENS, FRANCE.

the Arno, at Florence, Italy, was built in 1569 by B. Ammanati. The very slight point at the crown is concealed by decoration, giving the arches the appearance of being elliptical. The bridge has long been noted for artistic merit. The piers are 26 feet wide, while the three arches have a span of about 95 feet each, with a rise of 14 feet 10 inches.

The Pont-y-Prydd, over the river Taff in Wales, was built in 1755



MAIN STREET BRIDGE, WHEELING, W. VA.



RAILWAY BRIDGE OVER THE PRUTH, JAREMCZE, AUSTRIA.
(The longest masonry span in Europe, 213 feet)



RAILWAY VIADUCT, MORLAIX, FRANCE.

by William Edwards. It is a segmental arch, with a span of 140 feet and a rise of 35 feet. In 1746 Edwards built a bridge of three spans, and contracted to maintain it for a period of years. It was destroyed or washed out in less than two years, and he then built a bridge with a



PAINESVILLE BRIDGE, OVER GRAND RIVER OHIO.

single span, which fell down in 1751, before it was finished. This failure was due to a defect in the design, which he corrected in his third and successful attempt by constructing circular openings in the spandrels, as shown in the illustration, thus reducing the weight over the haunches. Although the expedient was borrowed from the French, the Pont-y-Prydd is a very early example of the use of hollow spandrels.

Another arch with hollow spandrels is illustrated in the Pont du Cint near Amiens, France.

The Main Street bridge at Wheeling, West Virginia, built in 1892, enjoys the distinction of being the second longest masonry arch in America. It has a span of 159 feet, with a rise of 28.4 feet. The exterior spandrel walls are built up solid, but the space between them is open, and divided into several longitudinal vaults, by interior spandrel walls of brick, covered with small transverse brick arches carrying the roadway. The tendency of the transverse arches to push out the exterior spandrel walls at the top is resisted by iron tie-rods. The indeterminate advantage in strength derived from the spandrel walls is more than offset by the deceit in the construction — concealing hollow spandrels behind solid walls. If the spandrels were solid, as they appear to be, the ring would be overloaded. To avoid

offence to aesthetics, the construction should either disclose the hollow spandrels, or the ring should be proportioned to carry solid ones.

The longest masonry arch in the world carrying a railway is in the Jaremeze bridge in Austria, over the river Pruth. It was built in 1892 by M. Ludwig Huss, chief engineer, and has a span of 213 feet, with a rise of 59 feet. The design was developed after the extensive Austrian experiments had been made, and embodies the most approved practice of voussoir arch construction. The hollow spandrels are both scientifically and artistically designed.

Another European railway viaduct is the one on the Paris & Brest Railroad at Morlaix. It is 934 feet long, and 207 feet high above the quays.

The number of masonry railway bridges in the United States has, until recently, been limited by the demand for cheap and temporary construction. There are, however, a few very good examples. The Painesville arches on the Lake Shore Railway illustrate how much beauty may be obtained by correct proportions, without resorting to ornamentation, which is often inappropriate—not in harmony with either the surroundings or the purpose of the structure. The bridge consists of four semi-circular arches, each of 80 feet span and about 90 feet high, and carries two tracks. Three or five spans would have



STARRUCCA VIADUCT, NEAR SUSQUEHANNA, PA.

been more pleasing, but in other respects the structure is most satisfactory.

The Starrucca viaduct, near Susquehanna, Pa., was built in 1847, to carry a single track of the old broad gauge of the Erie Railroad,



RAILROAD BRIDGE OVER BLACK RIVER, ELYRIA, OHIO.

but without any addition to its width it now accommodates two tracks of standard gauge. It is 1200 feet long and 110 feet high, with spans of 51 feet. A much more pleasing effect would have been produced by semi-circular arches than by the flat arches shown in the illustration. As a general rule, when the height greatly exceeds half the length of the span, semi-circular arches are preferable, not alone on account of appearance, but because the horizontal thrust is less; and, when the piers and abutments are very high, it is desirable to keep the horizontal thrust as low as possible. This is one instance out of many that illustrate the convergence of scientific and aesthetic principles in design; and, as they have not been shown to diverge, it is reasonable to presume that they are always in harmony when truth-



WISSAHICKON BRIDGE PHILADELPHIA AND READING RAILWAY



MELAN ARCH, EDEN PARK, CINCINNATI, OHIO.



MELAN RAILWAY BRIDGE OVER SOUTHERN BOULEVARD, DETROIT, MICHIGAN.



MELAN ARCH BRIDGE OVER PASSAIC RIVER, PATERSON, N. J.

THE MASONRY ARCH BRIDGE.

fully applied. The projecting stones just below the springing line were used to rest the centers on during the construction of the ring, and allowed to remain as supports for scaffolding for future repairs.



MELAN ARCH BRIDGE, KANSAS AVE., TOPEKA, KANSAS.

They are chiefly interesting as being a rare modern example of an almost universal practice with the Romans. Without any material increase in cost, the addition of cornices around the piers at the springing line and a more emphatic demarkation of the horizontal line of the roadway, as in the Painesville bridge, would have been a great improvement.

An arrangement of doubtful economy is shown in the three-span



MELAN HIGHWAY BRIDGE, ROCK RAPIDS, IOWA.

double-track bridge at Elyria, Ohio. Each span is formed of two parallel semi-circular arches about 9 feet wide, with a space of 4 feet 3 inches between them. The masonry is corbeled out to meet at the



TYPICAL STEEL TRUSS HIGHWAY BRIDGE.

top, and carries a solid road-bed about 26 feet wide. The length of the bridge is 234 feet, and each span is 60 feet. The pilasters on the piers have no purpose, and therefore detract from the effectiveness of the structure. Some years after the bridge was built, the tracks were raised about seven feet to improve grades. An equal amount had to be added to the height of the spandrel walls, thus destroying the proportions and giving it a top-heavy appearance.



MELAN ARCH BRIDGE, HYDE-PARK-ON-HUDSON.

The Wissahickon bridge, on the Philadelphia & Reading Railroad, is 510 feet long and 103 feet high above foundations, and has five semi-circular arches of 70 feet span each. It was designed and built in 1881-2, by Mr. C. W. Buchholz, M.A.S.C.E., and cost \$375,000, or a little less than \$3 per horizontal square foot of structure.

That many iron and steel bridges have been built where all the conditions, physical and economical, favored the masonry arch, is due in part to a lack of confidence in, and appreciation of, its merits, born of defective conflicting theories and approximate methods of analysis. As a result of the recent development and promulgation of methods which compare favorably in exactness and simplicity with those used for a truss, engineers and builders are giving more consideration to

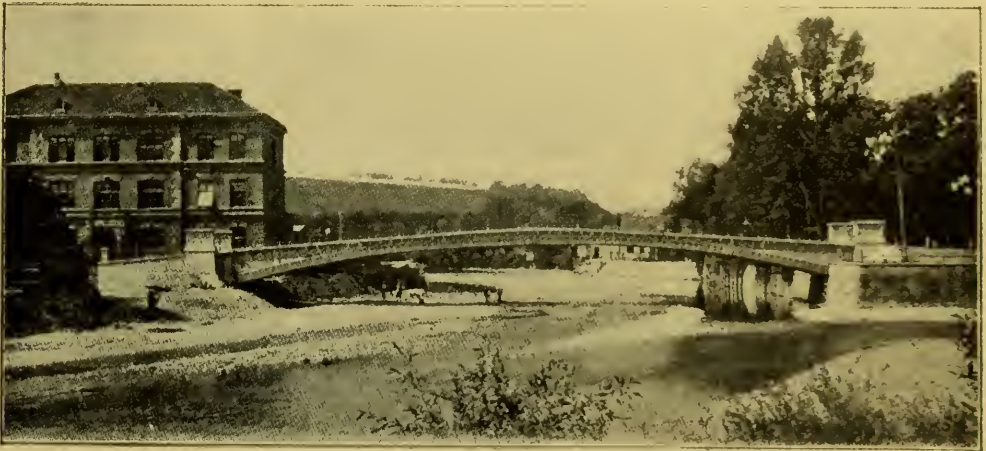


MELAN ARCH IN PARK, STOCKBRIDGE, MASS

the arch. But a more potent agency is the growing demand for better and more permanent construction of roads and bridges, due to the increasing wealth of communities, with the concomitant improvement in taste.

Forty years ago wooden bridges were, with rare exceptions, the only kind built in the United States. With the development of the iron industries, bridges constructed of cast and wrought iron, and a little later, entirely of wrought iron, largely displaced wooden bridges on both railways and highways. During the last fifteen years steel has succeeded in entirely displacing wrought iron, nearly usurping control of the entire field of bridge construction. Until within the last decade, the floors of all these bridges were of wood. The railway-

bridge floor consisted of wooden ties laid on the iron or steel stringers, and the highway-bridge floor of plank, laid usually on wooden joists, sometimes on steel joists. The wooden railway floor was a constant expense to maintain, a source of some danger, and difficult to keep in good surface. Consequently, with more money available and reduced cost of bridge materials, there came a demand for solid-floor bridges. A few railroads revived the construction of masonry arches, but a number of them experimented with steel troughs filled with gravel or stone ballast. The steel plates under the ballast were found to rust so rapidly that in the succeeding plans the ballast was omitted and the rails were laid directly on the steel plates. The indications are that the next step will be in the direction of the masonry arch, for it will be found to be the cheapest structure in the end, when the local conditions do not render it impractical. Steel, however, will retain



THREE-HINGED MELAN ARCH, STEYR, HUNGARY.

the advantage wherever very long spans or maximum headroom underneath are required.

A railway steel girder span 60 feet long, with a solid floor, costs about \$1,600. The capitalized cost of maintenance and renewals amounts to about \$400, giving a total cost of about \$2,000, while the equivalent part of a masonry arch can be built for about \$1,800.

With the improved street pavement in cities and macadam roads in the towns and counties, the plank floors of the highway bridges, requiring constant repairs and renewals, presented a feature objectionable to the advocates of good roads, and of greater expense to the communities, not only for maintenance, but also for accidents caused by broken plank. A solid pavement or macadam, to correspond with the other parts of the road, succeeded the plank floor on first-class bridges. The pavement or macadam is laid on a concrete base, under

THE MASONRY ARCH BRIDGE.



PONT DE JENA, PARIS. TROCADERO IN DISTANCE.

which there are either brick arches or steel buckled plates, which are, in turn, supported by the steel beams or stringers of the bridge.



PONT DE LA CONCORDE, PARIS.

It soon became evident that this construction was nearly as expensive as masonry arches, and in some locations the latter are the cheaper, even in first cost.

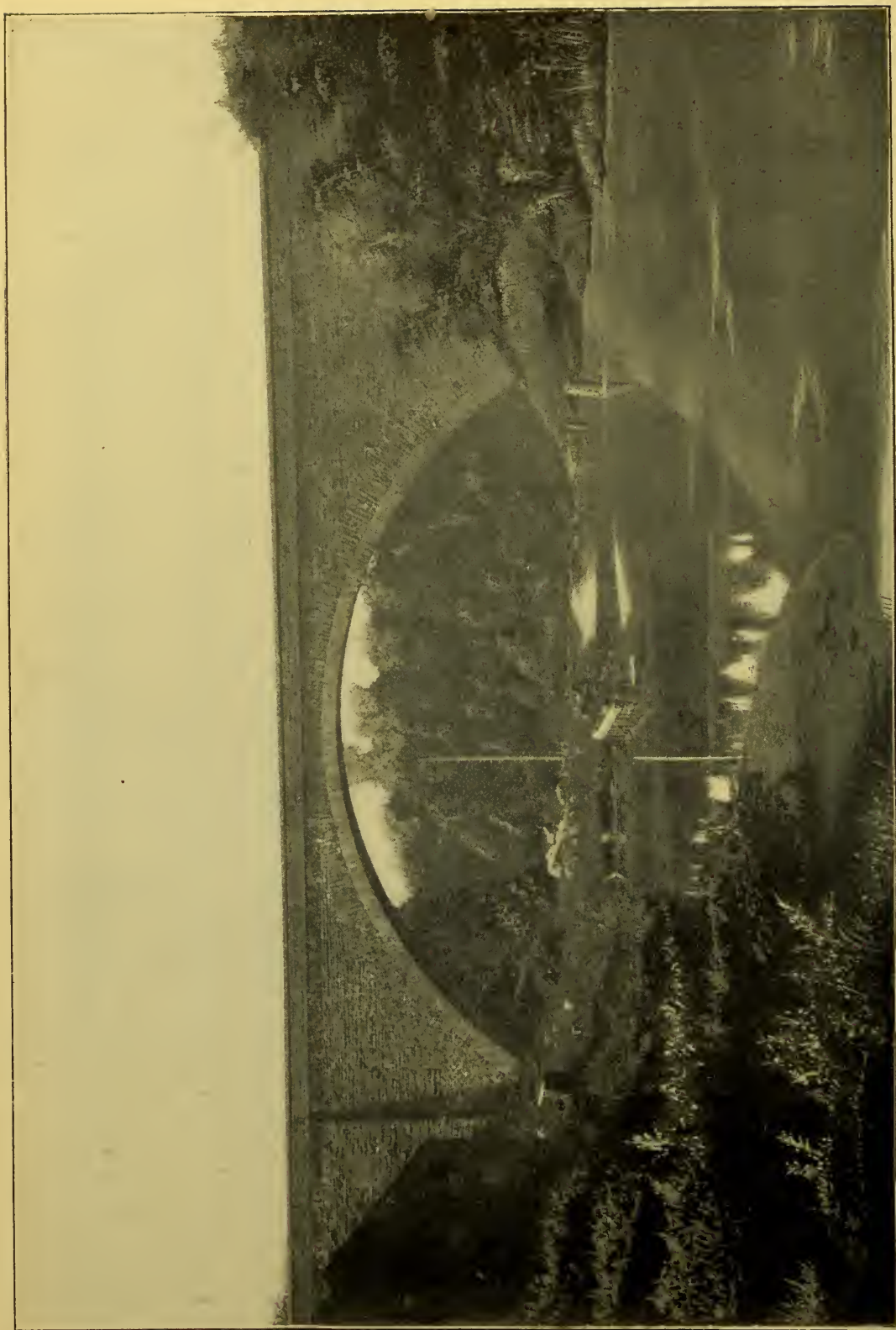
The masonry arch has another important advantage over the steel bridge, especially for railways, in the relative ratio of the moving loads to the weight of the structure itself. Except for very long spans, the weight of a steel bridge is small compared with its moving load; consequently any great increase in the loads, over those for which it was designed, overstrains the steel. Many bridges, otherwise perfectly good, have had to be replaced by heavier structures to sustain the greater loads. With the masonry arch, the weight of the



PONT AU CHANGE, BOULEVARD DE SÉBASTOPOL, PARIS.

structure is many times greater than its moving load, and therefore the latter may be doubled without materially increasing the stresses, or seriously overloading the bridge. When these considerations, and the small cost of maintenance, are once fully comprehended by the public, the masonry arch will return to the position it once held as the first of all among the types and classes of bridges; and our landscapes, instead of being defaced with offensive girders and trusses, will be adorned.

One cause of the increased number of masonry arches built in the past few years is the use of concrete, and the perfection of the application to the arch of concrete-steel construction, or concrete re-



CABIN JOHN BRIDGE, NEAR WASHINGTON, D. C., FOR AQUEDUCT AND HIGHWAY.
Span 220 feet; the largest masonry span in the world.

inforced with steel. The favor with which concrete is now received is largely due to the great improvement in quality and reduction in cost of Portland cement. The Romans have bequeathed to us ample evidence of the durability of concrete, even when made of inferior cement. There is also sufficient proof of the absolute protection from corrosion afforded by concrete to steel entirely embedded in it. All the advantages of the voussoir stone arch, and more, are obtained with the solid arch of concrete steel, at a cost nearly as low as that of the solid-floor steel bridge. A number of bridges of this class have been built in the United States, using the system developed by Professor Joseph Melan, which is a direct outgrowth of the Austrian experiments; the system employs stiff steel ribs or beams, embedded in concrete, to form the arch ring.

The Kansas Avenue bridge, at Topeka, is the longest of these. It has five arches, one of 125 feet, two of 110 feet each, and two of 97.5 feet each. The three-centered curve of the intrados was developed by adapting the ring to the requirements of strength and economy. Had a graceful curve been given to the roadway, instead of having the grades meet at an angle, the appearance would have been improved.

The Eden Park bridge in Cincinnati, like the Topeka bridge, is finished in molded concrete. The span of the arch is 70 feet. It has a concrete parapet, and, altogether, is a very artistic structure.

The Southern Boulevard bridge in Detroit, Mich., under a railroad yard, is wide enough to accommodate eight tracks. It is a Melan arch with a span of 50.25 feet, is on a skew, and is 105 feet wide. The face is finished in ashlar masonry, as is also the Melan arch bridge at West street, Paterson, N. J. The latter has three spans of about 89 feet each, and is 50 feet wide. The abutments are on a skew.

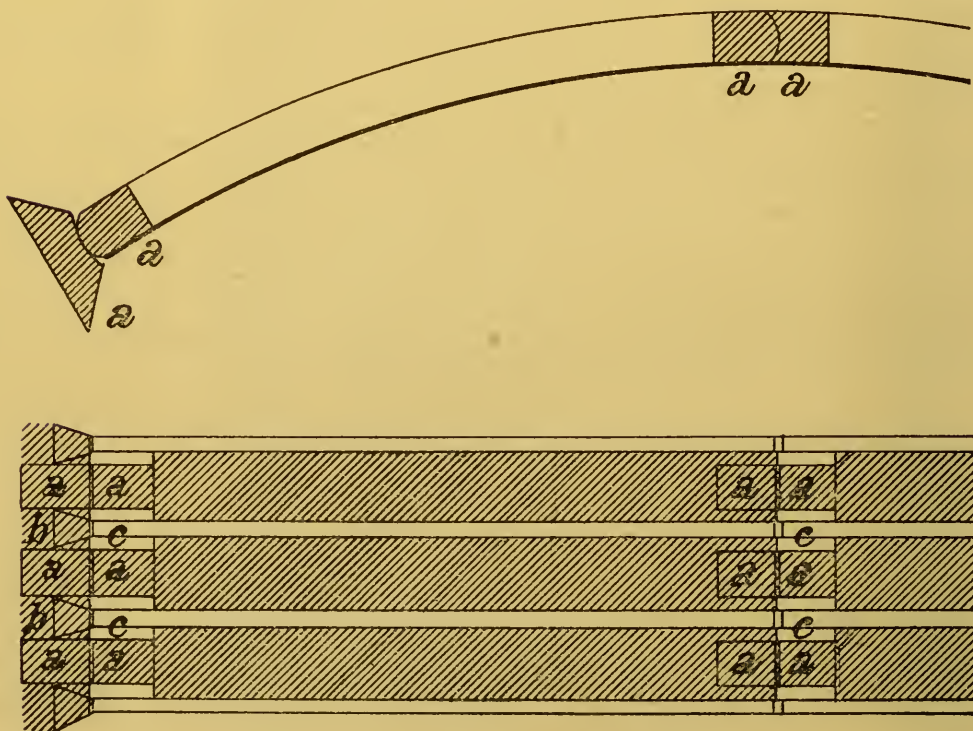
The 30-foot-span Melan arch at Rock Rapids, Iowa, is illustrated with an ordinary steel truss bridge, to show the relative worth of the two types from an aesthetic view-point. Both the arch and the truss were built as cheaply as was consistent with stability, without regard to appearances; but the arch is in harmony with its surroundings and purpose, and looks durable, while the truss lacks both of these merits.

The bridge at Hyde Park-on-the-Hudson, on the private grounds of Mr. F. W. Vanderbilt, is a Melan arch of 75 feet span, with the face finish and balustrade made entirely of molded concrete. The intrados is of five centers, approximating an ellipse.

The Melan arch footpath bridge, in the park at Stockbridge, Mass., has a span of 100 feet with a rise of but 10 feet. The thickness

of the ring at the crown—only 9 inches—indicates what the possibilities are with this system.

In cases where unyielding foundations for the abutments could not be secured, European engineers have resorted to the use of hinges and semi-hinges, which permit of some movement of the abutments without injury to the arch. Hinged arches of iron and steel are very common, but the value of the device as applied to masonry arches has been somewhat exaggerated. In some cases it is the only practical way to overcome the difficulties of securing a proper foundation, but more often other means are available. Where piles can be used, they



HINGE JOINTS IN THE MELAN ARCH AT STEYR.

can be driven alternately vertical and inclined, at little additional cost, thus providing for the horizontal thrust of the arch. It has been suggested that the introduction of hinges simplifies the calculation of the stresses, but the amount of work and trouble saved is relatively small, and should not be a determining factor.

The Melan arch at Steyr, Hungary, has three hinges, at the skew-backs and at the crown. The span is 137.76 feet, and the rise is only a little more than 9 feet, or about one-fifteenth of the span. The extreme flatness of this arch, rendered necessary by the low grade of the street, in connection with the nature of the foundations, made the use of hinges the only practical solution of the problem. The sec-

tional views show the arrangement of the hinges, and also the characteristic Melan system of construction, already described.

In many cities of Europe the memorial bridges are objects of artistic and historical interest. They are generally arches of masonry, almost as enduring as the very ground they spring from. Many of the old Roman aqueduct bridges, enduring evidence of the wisdom and skill of their builders, take their names from, and are memorials of, the emperors under whose orders they were built.

The Pont de Jena in Paris, France, was built under the edict of March 27, 1806, by M. Lamandie. The imperial decree dated January 13, 1807, named it to commemorate the battle of Jena, in which Napoleon crushed the Prussians on October 14, 1806. When the allies occupied Paris, the Prussians threatened to destroy it, but Wellington prevented them from executing their threat, by keeping a British sentry on the bridge. The five segmental arches are 91.75 feet span by 10.75 feet rise, and have 67 voussoirs in each ring. The cornice is 3 feet deep, and the parapets are 3.17 feet high. The width between parapets is about 42 feet.

The Pont de la Concorde is also called the Bridge of Louis XVI. It was built by Perronet between 1787 and 1791 A.D. It also consists of five segmental arches, but is not so beautiful as the Pont de Jena.

Another very beautiful bridge in Paris is the Pont au Change, on the Boulevard de Sebastopol. The present structure was built in 1859, at the cost of about \$255,000, and has three elliptical arches of nearly 104 feet span each.

Leaving out of consideration one or two inconsiderable structures, there is not a single masonry arch memorial bridge in the United States. There is only one memorial bridge, and that, being of metal, has a lease of life so short that its purpose as a memorial is defeated. The memorial feature, however, was an afterthought.

For the last fifteen years efforts have been made to secure a memorial bridge over the Potomac, from Observatory Hill in Washington City, to Arlington cemetery in Virginia. At various times three or four official reports have been made on the project by officers of the corps of engineers, and each one has recommended an iron or steel bridge. Three of these reports submitted plans for a bridge with ordinary truss spans, with a draw or swing span in the center, without any artistic merit whatsoever. The estimated cost of such a structure is now placed at nearly \$1,500,000. One plan contemplated a series of steel arches, while another called for a suspension bridge with

masonry arch approaches. The latter could, no doubt, be so designed as to present a very graceful appearance, but its cost was estimated at \$3,500,000, which is more than sufficient to provide for a permanent high-level structure of masonry arches.

These official reports have all stated that masonry arches would be of shorter spans, and would therefore require more piers in the river than a steel bridge. Each then recommends a steel bridge with spans of only 300 feet.

General Meigs built the Cabin John aqueduct and highway bridge near Washington forty years ago. It is the longest masonry arch in the world, having a span of 220 feet. The bridge over the Adda, near Trezzo, Italy, built by order of Visconti in 1380, and destroyed by Carmagnola in 1416, had a span of 251 feet with a rise of 88 feet, and a total thickness of ring of only 4 feet. The Romans built spans of 140 feet nearly two thousand years ago. American contractors have offered to build and guarantee voussoir spans as long as 280 feet, and in one case a solid arch of masonry of 300 feet span.

That an arch of 400 feet span is no more difficult to-day than the spans just mentioned were in their day can be demonstrated; but with the recently perfected methods of analysis, and improvements in materials and facilities, the construction of an arch of 300 feet span is lacking in all the elements of daring that attended the early undertakings.

In that center of historic interest, the capital of the United States, with the Washington monument, the executive buildings, and the new Potomac park on one side, and the beautiful Arlington cemetery on the other, no bridge but a masonry arch would be a fitting memorial to America's national heroes. It is to be hoped that this opportunity for the government at Washington to set an example for municipalities to follow, in building really permanent and aesthetic structures,—a true index of the state of progress in the constructive arts,—will not be lightly thrown away by the erection of a hideous truss bridge.

COMMERCIAL ASPECT OF ELECTRIC TRACTION IN GREAT BRITAIN.

By Emile Garcke.

THE scientific principles underlying the superiority of electric traction for the propulsion of tram-cars are practically the same all the world over. It is when we consider the commercial and legal aspects of the question that we find some explanation why this superiority is not manifested in the same degree, under apparently like conditions, in different countries.

One of the fundamental advantages possessed by the overhead system of electric traction is that the power is generated for all the cars at one or more central points, and is distributed over the entire system and expended at the points where the traffic requires it and in proportion to the volume of the traffic to be carried; while in the case of either horses or steam, and also in the case of the self-contained electric-accumulator car, and some other systems, each car requires to be accompanied, for the whole of its journey, by its own motive power, which must be sufficient to start the car and to carry the maximum load of passengers, and must be able to overcome the steepest gradient. As the abnormal demand for power for these purposes is only occasional in time and place, it follows that there is considerable waste when the car is empty, or on the level, or at rest. Moreover, in the case of horse traction, about four-fifths of the horses required for the cars are resting or feeding, while the work is being done by the other one-fifth, and the service of cars cannot be increased to meet an exceptional demand without permanently providing this wasteful margin of power.

Now, in the case of electric traction, if the traffic calls for a more frequent service, it can be provided without very largely increasing the working expenses. Of course additional capital expenditure has to be incurred to furnish more cars and other plant, but a much smaller increase of traffic will justify the running of an additional car, with the overhead system of electric traction, than in the case of other systems.

Many of the other advantages of electric traction, such as avoiding the objections arising out of the employment of horses or steam locomotives in the streets, are too obvious to call for mention; and the

many engineering or technical benefits surrounding the use of electricity for the purposes of traction are not within the scope of this article. Suffice it to say that the net result of the adoption of electricity for tramways is not only that, up to a certain point, an ever-increasing traffic can be carried at a relatively less cost of working; but this very fact tends to produce the increased traffic. It is a case of the supply creating the demand. An improved and quicker service encourages people to patronize tramways who otherwise would never think of traveling in tramway cars. In fact, the basic argument for the adoption of electric traction is that it creates passenger traffic which at present does not exist. Without any increase in population, more people are carried by electric tramway cars than formerly by horse or steam cars; and this without in any way detracting from the traffic on the ordinary railroads, except in the case of purely urban or suburban lines. Electric cars are intended for people who at present either walk or do not move about. They serve the busy man who goes from house to house—not from station to station—because he is unable to resist the temptation of entering an attractive-looking, well-equipped, and well-lighted car which stops and starts quickly, picks him up wherever he is without his waiting for it, and puts him down wherever he wants to be.

Hence, electric tramways are in every sense popular. They do not depreciate properties, but on the contrary, they improve the character of the district they pass through; properties appreciate in value and extensions of the tramways are invariably called for; whereas, in the case of the old forms of tramway, every extension was strongly resisted.

Provided an electric tramway system is extended on judicious and sound commercial principles, then, the larger the system, the lower will be the proportion of working expenses to the total receipts, and the better will be the percentage of profit on capital expended.

This, in general terms, accounts for the fact that tramway companies, which formerly could not keep their heads above water, are able to make profits on largely increased capital. It is, however, this enormous increase of capital inseparable from the adoption of electric traction which gives rise to all the difficulties. The fullest advantage of electric traction and the greatest possible reduction in working cost can only be secured by an enormous capital outlay and it is in this phase of the problem that investors in electrical-tramway undertakings are exposed to the greatest danger, because the optimism produced by the first success may lead those who are inexperi-

enced in the business to make extensions of a kind which may have the effect of neutralizing, instead of increasing, profits.

The advantages of electric traction were fully recognized by street-railway men in America some ten or eleven years ago, and were forthwith realized to such an extent that, whereas, in 1890 there were 5,400 miles of tramways (or "street railways") worked by horses, there are now only a few hundred miles so worked, and horse traction is rapidly disappearing altogether, while there are now, probably, not less than 20,000 miles of street railways worked by electricity in America.

In 1887 there were, in the State of Massachusetts, 470 miles of tramways, all operated by horses. There were, in 1896, over 1,080 miles of track, all but 62 miles of which were equipped for electric power. That is to say, in the State of Massachusetts, with an area and a population only about one-fifteenth of the United Kingdom, there were more electrical tramways than there were tramways of all descriptions in the United Kingdom.

When the success of this system had been demonstrated in the United States, engineers in Europe also turned their attention to the subject; and on the continent, people were not slow to avail themselves of its benefits. But in England there has been, until quite recently, a tardiness to adopt the new form of locomotion, the reason for which cannot be obvious to those who have not been engaged in the struggle to overcome the difficulties and obstacles which have existed and which have given rise to a condition of things which may even now divert the development of the industry into wrong directions, and make progress less desirable than stagnation.

On this point it is interesting to have the testimony of so well informed and impartial an authority as the special committee appointed by the State of Massachusetts to investigate the relations between cities and street-railway companies in America and elsewhere. They state, in their report of February, 1898, that in America grants to use the public highways have been given entirely without adequate protection to the interests of the town, the officials thinking only of the benefits to be derived by the people from being placed in close communication with some neighbouring town or city; while in Europe the rigid restrictions imposed on companies desiring to use the streets for tramways "have restricted technical development to such a degree that it may be said that there scarcely exists in any European country a street railway which approaches in its technical and commercial methods those of an ordinary American city. In England the gen-

eral law relating to tramways has imposed such burdens that no company has felt justified in making proper extensions, and we find the development of street railways in London and in the larger provincial cities is behind that of cities in the United States with populations far smaller than those of these great towns.

As I have stated, there are no engineering difficulties in the way of the adoption of electric traction in England. It is true that in America streets appear to have been made for tramways, while in England the topography of the town taxes the ingenuity of engineers; but, on the whole, facts and figures show that in many respects, Europe is if anything even a more favourable field for electric traction than America.*

What then, are the obstacles? The answer is not a simple one, and requires at least a brief statement of some political and sociological tendencies which have existed in Great Britain during the last decade or two.

All economic problems are highly complex, and the mechanism which sets social forces in motion is not always visible; but there is

* For a long time we were told that English people would not tolerate overhead wires and that, until some more attractive looking system was developed, electric traction would not be adopted. But this is not correct. The mass of the people knew nothing about it. These matters are decided by the town councillors and they never considered the question. As soon as they were forced to consider it and to examine the overhead system they decided in favor of it.

A committee of the Glasgow Corporation reported in July, 1896:

"With regard to its appearance and operation as we saw the system on a large scale in Hamburg, we found that the real objections to it are very much less on the spot than we had anticipated."

A committee of the Belfast Corporation reported in March, 1896:

"All practical objections to the overhead system have been surmounted, and any exception thereto from an æsthetical point of view has been reduced to an almost infinitesimal quantity in the best examples of the overhead system."

The general manager and the engineer of the Glasgow Corporation tramway reported in November, 1896:

"We are perfectly reconciled to it, and feel that it only wants to be seen to be appreciated."

The committee of the Sheffield Corporation reports:

"The chief objection urged against the overhead system is its appearance, but the deputation, from their own personal observation, have come to the conclusion that very little objection can be taken from an æsthetic point of view."

The committee of the Hull Corporation reports in April, 1897:

"The objection[*to* overhead wires] appears to be largely due to prejudice, and is to a great extent removed by familiarity with the overhead equipment, and to a still greater extent removed by a recognition of the superior facilities afforded by electric traction."

The committee of the Liverpool Corporation reports in July, 1897:

"With regard to the objections that have been raised to the overhead system on account of . . . unsightliness of overhead construction . . . the deputation would point out . . . that with properly designed supports, and with wiring carried out with due regard to appearance, the unsightliness is so far minimised as practically to disappear."

The alleged objection to overhead wires is not therefore the reason for the delay in the adoption of the system in Great Britain.

observable a swing of the pendulum of public opinion in these matters as well as in politics and other departments of life. The great development of industries by means of private enterprise in the early part of the present century has produced a reaction which, during the last twenty or thirty years, has had the effect of discouraging the creation of undertakings partaking of the nature of monopolies. At one time practically all new undertakings of this character were established by corporate or governing bodies, and private individuals were, to all intents and purposes, prohibited from participating. Then, for a time, the expression of public opinion and the policy of Parliament were in favour of encouraging private enterprise. Political economists pointed out the superior energy of individual enterprise; the laws of partnership were altered to enable the capital of many individuals to be united for a single purpose, and a great stimulus was given to industries of every kind by the progress of engineering science and the accumulation of capital seeking investments. Canals, docks, light-houses, turnpike-roads, bridges and ferries, railways, and gas and water undertakings were all carried out by reason and in consequence of the protection and encouragement offered to private capitalists; and it must be admitted by even the most ardent collectivist that by this means, the country has been supplied with necessities and conveniences which the State or municipalities would never have provided. But, on the other hand, it must also be admitted that the monopolies which were granted were not sufficiently restricted in the interests of the public. This led to an outcry against the further creation of big monopolies, and the Board of Trade and also Parliament recognized that there were many points in which the interests of these companies were at variance with those of the public. The conditions, however, which were imposed for the purpose of preventing these monopolies from being injurious to the public were very tentative, and a former permanent secretary of the Board of Trade has stated that these remedies have often proved inadequate and sometimes mischievous, and that, whilst it is right and necessary to impose some restrictions, yet, without great caution and wisdom such restrictions are likely to be injurious to the public as well as to the companies.

One of these tentative and mischievous measures, prejudicial alike to the public and investors, was the Tramways Act of 1870. That was the first general act of Parliament in this century which in its effect discouraged private enterprise in Great Britain. Twelve years later it was followed by the Electric Lighting Act; but by that time.

capitalists had become shy. They had seen the effect of the Tramways Act and they would have no more of the principle which it expressed. They did not make the mistake of tramway investors who had put about twelve millions of capital into the tramway industry and had thus given British legislators at that time the impression that the principle embodied in the Tramway Act was acceptable to capitalists. Although many millions of capital were subscribed in 1881 and 1882 for electric lighting, prior to the passing of the Electric Lighting Act, not one of the sixty-two provisional orders granted to companies in 1883 was carried out. Capitalists declined to go on with a business which, if successful, could be taken away from them by local authorities at the end of twenty-one years upon terms of paying the then value without regard to past or future profits, goodwill, or other like considerations. But it nevertheless took Parliament six years to recognize the mistake which had been made by the passing of the Electric Lighting Act of 1882. It was not until 1888 that an act was passed amending the period of purchase from twenty-one to forty-two years. Then, for the first time, electric lighting went ahead in Britain, although other countries had long previously enjoyed its benefits.

But the poor tramway companies have never had their oppressive act of Parliament altered. These undertakings are now being bought up by local authorities after a twenty-one years' pitiful existence, at the price of the old rails and plant. With the exception of a few undertakings in large cities or otherwise favourably situated, all tramway companies in Great Britain have proved lamentable failures. And why? Because the companies, knowing that they would be bought up at the end of a few years, have been unable to expend any capital on improvements, and have been debarred from doing what, in the words of Bacon, is so essential to the development of all commercial enterprise :

"A man may not look to sow and reap at once,
But must prepare business, and so ripen it by degrees."

The limited tenure allowed by the Tramways Act is not, however, the only reason which accounts for the non-success of tramway companies in Great Britain. We are frequently told that tramway companies have been over capitalized; and as a matter of fact the capital expenditure per mile of English tramways is very much in excess of the capital expended on street railways in America, notwithstanding the improved method of traction there experimented upon and adopted.

We are told that English tramway companies could not be expected to make satisfactory returns upon their inflated capitals. Of course not; but what is the reason for their exceptionally large capital expenditure? I have no wish to defend unscrupulous promoters of companies and I am ready to admit that sometimes companies are formed on the basis of the promoters and vendors taking the whole of their profits at the formation, instead of making them dependent upon the success of the companies; but a careful and impartial inquiry into the history of tramway undertakings discloses the fact that, where there has been over-capitalization, it is mainly the result of the conditions imposed upon promoters by Parliament, the Board of Trade and the local authorities. It is not necessary for proof of this statement to show that every shilling of excessive capital has been expended upon works. If an undertaking is surrounded by undue risks, obligations, and difficulties, it will cost more to establish and to complete it. Greater efforts and sacrifices have to be made to get the undertaking financed and carried out. All kinds of expensive precautions against financial disaster have to be taken and paid for so that, without increasing the profits of promoters, more money is taken out of the undertaking for promotion expenses than would be the case if the undertaking were permitted to be a normally safe investment.

One of the most fruitful sources of trouble has been the fact that, under the Tramways Act, the assent of the local authorities has to be obtained, as a condition precedent, by the promoter of a tramway. This condition should not *per se* be a hardship upon the promoters; but, unfortunately for the development of the industry, the local authorities have made it so. The veto which they possess under the Tramways Act enables them to impose onerous conditions, not to be resisted by promoters, some of whom would rather accept impossible conditions and obtain a concession which they hope to sell than face the loss of the expenses they have incurred.

These impossible conditions take a variety of forms; but, unless the scheme is abandoned, they are expressed by inflated capital or reduced profits, or both, and they manifest themselves to the general public by the inability of the company to give satisfaction.

The whole tendency of late has been to regard commercial promoters of public works not as benefactors, or as people rendering a public service and therefore entitled to a fair reward for their labours and risks, but rather as people who have no interests in common with the public they serve. In theory and in law, the right of a tramway company to use the street is granted on the sole ground that it is for

the interest of the public that they be allowed to do so. The grant of the powers is an accommodation to the public and not a privilege or gift to the company, and, therefore, the company should be fairly remunerated for rendering a public service; and the better the company does the service, the better it should be rewarded; but local authorities now generally take the view that the promoter of public works is an usurper who should be mulcted and discouraged rather than assisted.

This view is not held by responsible legislators nor by representative institutions, but is forced upon them by the organizations and influence which municipal corporations are able to bring to bear.

When the Electric Lighting (Amendment) Act of 1888 was under discussion, the Society of Arts presented a petition to Parliament which stated that "those willing to provide the electric light are hindered by the existing state of the law, and that in consequence the development of electric lighting in England has not been equal to its development in other countries, where no such artificial hindrances existed. The Institution of Civil Engineers and other bodies supported this view by resolutions and petitions. The prime minister, on the discussion of the bill, said that he inclined "to go back to ideas of less restriction and greater freedom in this matter, and to allow enterprise to have its full swing, to remove the obstacles which had hitherto impeded it, and offer terms, not such as they thought the capitalist ought to accept, but which they found by experience he would accept. So it might be possible, by giving rights which were generous and large, to procure for the public the full advantage of those scientific inventions which other nations had and which now, by our restrictive policy, we prevented the public from enjoying without doing any good to the local authorities, which were the subject of so much tender care."

Again, in the last session of Parliament a select committee of both houses, after hearing a mass of evidence tendered by the Board of Trade, by local authorities, and by electrical companies, reported as follows:

"The Committee think the provisions of the Electric Lighting Act, 1888, enabling the local authority to purchase an undertaking after a term of years, inapplicable, as a general rule, to the case of an undertaker supplying energy in bulk at high voltage, but there may be special cases where it is desirable that the local authorities should have the right to purchase reserved to them. To meet such cases they suggest that the Board of Trade should have power to insert the purchase clause in the Provisional Order, if the local authorities concerned can, in the opinion of the Board, show good cause for such a course.

"The Committee consider that the provisions of the Electric Lighting Act, 1888, which require the consent of the local authority as a condition precedent to the granting of a Provisional Order, should be amended. In their opinion, the local authority should be entitled to be heard before the Board of Trade, but should not have, so to speak, a provisional veto, only to be dispensed with in special cases by the Board of Trade."

The adoption of electric traction by existing tramway companies involves, as I have stated, an enormous expenditure of capital. The old rails have to be replaced by heavier construction; new electric-motor cars, costing about £700 each, have to be provided in place of the old; electrical equipment is required in lieu of horses, and these have to be sold at a loss; the stables are no longer needed, and expensive power houses with delicate machinery have to be erected in their place. It is not an exaggeration to say that electric traction cannot be adopted on many of the existing lines without at least doubling the capital. Is it likely that any body of shareholders would agree to this expenditure with the risk of being bought out after the lapse of the few remaining years of the period of pre-emption mentioned in the act?

The foregoing are, briefly stated, the chief reasons why electric traction has not been adopted in Great Britain in substitution for existing forms of tramway locomotion; and also why, until the passing of the Light Railways Act, scarcely any new tramway lines were promoted under the Tramways Act even with the promise of the improved results to be obtained from working by electricity.

It is generally recognized that the local authorities are the custodians of the highways, and that it is their duty to protect the interests of the ratepayers; but the point which they ignore is that the people who provide a satisfactory service of electric tramways, or light railways, are rendering a public service which all who have witnessed the results of the introduction of electric traction in other countries admit are of enormous benefit to the towns and districts served by this form of locomotion.

There is no reason why England should not likewise secure these benefits if only her municipal authorities would approach this question in a fairer spirit and recognize the fact that so complex a business as that of electric traction requires a very large technical experience, is attended by considerable risks, and that the undertakers are entitled to a reasonable return for their services and for the capital invested.

Abundant evidence is available that this spirit is not generally adopted by local authorities in dealing with tramway undertakings; and the three following concrete cases will serve as illustrations.

(a) A tramway company sanctioned by Act of Parliament obtained statutory power to adopt electric traction. For the purpose of carrying this out, the angles of the loops or passing places on single lines had to be slightly eased so as to enable the electric car, which cannot—like the horse car—be pulled to one side, to pass over them. The corporation objected to these alterations being made, unless the company agreed to widen streets in other parts of the town. The result was that the introduction of electric traction was delayed until this legal point was settled, and the company has nothing to show for the unnecessary law costs it had to incur.

(b) Upon the invitation of a corporation, a tramway was promoted. The corporation insisted upon the scheme being enlarged by lines being added which were not needed, except, perhaps, to increase the value of some building plots, and which lines, in the opinion of the company, would not pay to work for very many years. Many other serious conditions were imposed, and as the company declined to accede to these conditions the corporation opposed the confirmation of the order at every stage of its progress; as there was no longer any prospect of the undertaking becoming remunerative, the order was withdrawn, and there is no electric traction in that town.

(c) In the case of a tramway worked by steam without any profit, application was made for the necessary powers to work the line by electricity. The corporation approved of the proposal, but made it a condition of their assent that the electrical energy should be purchased from an electric-light station which the corporation proposed to establish. The electric-light station by itself would probably not pay, as the town is a very small one; but the corporation hoped that, by obtaining the tramway as a customer, they would be able to make their proposed electricity-supply works remunerative; but so doubtful was this that they would not undertake to supply the electrical energy except at a price which would be higher than the cost of working the tramway by steam power.

These cases are typical, and they show the kind of difficulties which municipalities put in the way of undertakings, even in those cases where the desirability of providing electric tramways is admitted; but there are a large number of cases where, owing to the difficulty of getting any decision from local authorities, even this stage has not been attained, notwithstanding months and even years of weary negotiations.

One of the principal reasons urged by local authorities for their

harsh treatment of tramway promoters is that tramway companies in the past have been a failure commercially, that they have left the track in a bad condition, and generally, that they have failed to carry out their obligations. But this is the very result to be expected from the policy of imposing burdens which prove too heavy to bear.

It would have been better for the industry if, in the early days of the Tramways Act, promoters had been strong and honest enough to reject a tramway order which had been commercially spoilt by the heavy burdens imposed by local authorities as the price of their assent; for such undertakings are but an eye-sore and a source of trouble to everyone ever afterwards.

It will probably be answered by those who support the present movement in favour of the municipilization of industries that it does not matter if private enterprise is discouraged; that municipal corporations will take up the work which private capitalists refuse to undertake. I cannot attempt to state all the pros and cons of this question, but I will mention one fact that is not contentious, and which, I think, will show that this view is not compatible with the best and fullest development of this industry; that is, that if municipalities carry out tramways within their own areas, out-lying villages and towns too small to adopt the principle of municipalism are bound to be neglected and both the large towns and the sparsely-populated districts will suffer in consequence. If this, in turn, is answered by the argument that municipalities should be allowed by Parliament to work tramways outside their areas, then I say (without going into the question, among many others, whether people in one district should be rated for the purpose of rendering service to people in other districts) that it has already proved impracticable, notwithstanding the ambitious proposals put forward this session by Manchester, Glasgow, and other municipalities. The jealousies and want of unanimity between adjoining local authorities are such that a company whose tramway, only seven or eight miles long, passes through the areas of three local authorities, was requested by each authority to adopt an entirely different type of car, and it was only by reference to arbitration that this difference could be settled. Both Bradford and Leeds, only eight miles apart, have municipalized tramways, but they have not been able to agree upon a gauge common to both, and inter-communication by tramway is impossible. An industry which for its proper development must extend in every direction required by traffic is not suitable for the enterprise of municipalities whose operations should be confined to their own areas.

Several bills have been introduced in the present session of Parliament which will clearly raise the issue of municipalization of industries versus private enterprise; and the pioneers of electrical traction in the United Kingdom are awaiting the result with much interest; for promoters who have a sense of responsibility towards their shareholders are anxious to know whether they are needed for the development of this industry or not. If they are told they need not apply, then they will be free to employ their energies and capital in other branches of industry, in other countries if not in England. If, on the other hand, private enterprise in this industry is to be encouraged, then promoters of electric tramways should not be discouraged by being required to accept a smaller reward for their labours and risks than is afforded to other industries.

With the experience which the closing century has given, to legislators and government departments, of unrestricted monopolies on the one hand and throttled enterprise on the other hand, as well as of an intermediate industrial condition, as exemplified by the sliding scale of profits and auction clauses of the Gas Acts, it should not be very difficult to arrive at a fair and equitable adjustment between the interests of the public and the rights of the capitalist.

This problem will probably require a different solution for different industries; but in the case of tramways and light railways the right solution will, I think, be based upon the principle of municipalities owning the track, so as to give them the control of the streets, and the working of the line being entrusted to substantial parties who have the necessary experience for so complex a business. Some arrangement is no doubt desirable for the division of profits between the two parties, either on the analogy of the Gas Acts or some other fair basis which will secure to the municipality interest on the capital expended and provision for sinking fund, while offering to the operating company a reasonable reward for its service; but the lease to the operating company should be indeterminable so long as the company performs its part of the bargain and continues to give satisfaction to the public. It is only under these conditions that the public can expect the best possible accommodations and all the latest improvements and that the company is afforded a reasonable security of receiving the future rewards which are the outcome of present sacrifices.

THE NEW TERMINAL OF THE ORLEANS RAILWAY AT THE QUAI D'ORSAY.

By Jacques Boyer.

NEXT year France will invite the civilized nations of the world to come and admire the useful accomplishments of human activity. Discoveries of science, master-pieces of art, advances in commerce and industry,—in a word, all that contributes to increase the material well-being of man or his intellectual satisfaction will be represented there. To prepare properly for this triumph of peace many public works, the completion of which had been relegated to a more or less distant future, have been hastened, and their engineers have been put to the necessity of transforming Paris into an immense workshop.

From the beginning it was decided to permit the railways to come into the centre of the city. This is the first step toward the central railway terminus, so long needed, which will permit through travel from Calais to Marseilles, for example, without necessitating a stop at Paris. This through passage is at present impossible. Once arrived at the Gare du Nord (see Fig. 1), a passenger must claim his luggage, have it transported by vehicle to the Gare de Lyon, and, to continue his journey, again go through the formalities of taking a ticket, registering his luggage, etc. It was to avoid these losses of time and these useless expenses that the companies concerned elaborated the plans now in course of execution. While these will not, at their completion, sensibly modify the existing state of things, they tend to that end; but the companies proceed timidly and in a desultory fashion, instead of squarely attacking the problem. Plans for united action thus fail, and the result finally obtained will be unsatisfactory.

The Orléans railway is prolonging its tracks from the Place Valhubert to the Quai d'Orsay. The Compagnie de l'Ouest is moving its terminal station from the Champ de Mars to the Esplanade des Invalides, and this part of its system will be closely connected with the Ceinture railway at the Courcelles station. Meanwhile the Métropolitain underground railway is under construction—better late than never.

Railway lines, however, are not the most important works now

under way in the "City of Light." There remain, as subjects for following papers, the Alexander III. bridge, that remarkable work of MM. Resal and Alby, and the construction works of the exposition, which will be taken up in detail, describing the beginnings of work upon the palaces of the Champs-Élysées and the Champ-de-Mars. The present paper will discuss only the prolongation of the Orléans railway.

During the last dozen years the ever-increasing traffic of the French railways has compelled the companies to enlarge their Paris



FIG. 1. MAP SHOWING RAILWAY TERMINI IN PARIS.

termini. The Western and Northern systems were the first to set the example, while to-day the Eastern and Lyons systems are remodeling their old stations, which the development of business has overcrowded. These last two have rebuilt on their old sites, or, to speak more accurately, have erected new buildings in the immediate vicinity of the old ones. On this account these possess no great interest. For the Orléans company, however, the question was very complex. Its system, some 7,000 kilometres in length, covers a vast extent of the south and south-west of France, and the station at the Place Valhubert (see Fig. 1), where it terminated, was too far from the centre of Paris,—the city growing constantly towards the west, the precisely

opposite direction. Extension in this direction is not peculiar to the capital of France, for, curiously enough, it is also going on in the greater number of the large European cities.

The general movement tends, thus, to leave further and further behind the stations situated in the eastern part of Paris. Since Paris as yet has no metropolitan railway to facilitate access to the various stations from the central part, this inconvenience must be somehow remedied, especially as the present defective means of transportation is badly adapted to suburban service. Since the principal efforts of the Orléans company have been directed latterly to the betterment of



FIG. 2. RUINS OF THE COUR DES COMPTES, TO BE REPLACED BY THE NEW TERMINAL.

its suburban service, it was more than ever urgent for it to approach the centre of the city as closely as possible.

To give an idea of the improvement in its schedules it may be mentioned that, to-day, people living within a radius of 250 kilometres can pass the business day in Paris. Leaving home at about 8 o'clock in the morning, they reach Paris at noon. To be at home by 10 o'clock in the evening they return at 7 o'clock, thus having about seven hours in Paris for their business, as they can have luncheon and dinner in restaurant cars. Thirty-five years ago these future needs were unthought of, for in 1862 the Orléans company simply rebuilt its old station buildings, which had become too small, on the same site—at the Quay d'Austerlitz.

Later, in 1892, the management found itself confronted with a similar situation for its narrow-gauge system, which comprises two suburban lines,—Paris to Sceaux, 12 kilometres, and to Limours, 41 kilometres. This station, far from the centre of the city, at the Place Denfert (see Fig. 1), had to be abandoned for another at a more convenient point; so the company extended the lines to a terminus at the Luxembourg. Work on this

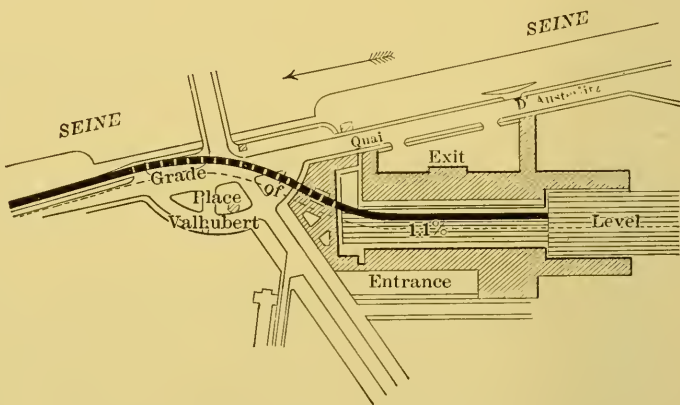


FIG. 3. PLAN OF THE OLD ORLÉANS STATION.

extension of one and one-half kilometres was finished in 1895, and resulted in an increase of earnings of 40 per cent.

Experience having thus fully justified the expectations of the engineers, and spurred them to a similar undertaking on a bigger scale, the terminus of the line will soon be transferred four kilometres further west, to the situation formerly occupied by the ruins of the Cour des Comptes (Fig. 2). This building, which was burned during the Commune of 1871, has remained unoccupied since. It was also, like the d'Orsay barracks, situated alongside of it, in a very bad condition. The demolition of these buildings gave rise to no great obstacles, and the large superficial area thus cleared gave excellent opportunities for the erection of the new building. The junction of the old with the new stations presented no insurmountable difficulties, the quais on the bank of the Seine being evidently the proper situation for the line.

The company entered into negotiations with the government, to which these properties belonged, and finally received a grant, voted by the chamber of deputies and ratified by the senate, on November 29, 1897. Soon afterward, in April, 1898, ground was broken. The pulling down of the buildings was carried on rapidly, and to-day the works of reconstruction are going on night and day at various points of the line. They are directed by MM. Brière and de la Brosse,* engineers of the Orléans Company.

To better set forth the interesting particulars that are encountered

* The author desires to thank M. de la Brosse for the permission kindly granted him to visit in detail all the yards and works, and to take notes at his leisure from the different contractors.

in going over these works, let it be supposed that one follows the bank of the Seine from the Quai d'Austerlitz up to the Quai d'Orsay, and thus enters immediately into the heart of the work.

The present station, at the Place Valhubert, is a hall 50 metres wide and 300 metres long, covering seven dead-end tracks, which are approached by four platforms. Of these tracks only the two central ones are prolonged to form the new extension. These, before turning toward the Seine, pass under the building containing the administrative offices, which, for various reasons, could not be removed without great expense. The grade from the Place Valhubert is very considerable—1.1 per cent. for 44 metres. Leaving the old station, the new line goes first to the Quai St. Bernard. Along this part the banks of the stream are occupied by a highway and a levee, or sloping bank, for unloading boats. The latter being very wide, it was possible to take 9 metres of it without inconvenience to vehicular traffic, and in this way an uncovered line was built upon the levee, up to the Sully bridge. The length of this section is 650 metres. From this point the road will be underground, up to the d'Orsay station, passing under the high part of the quai, where the vehicle traffic will continue as before. For ventilation windows will be cut on the river side, though these will not be sufficient for the lighting of the tunnel, which will be effected by electric lamps, distributed at regular intervals.

The works just below the Sully bridge are carried on in several sheds. As shown in the illustration (Fig. 4), the shed on the extreme left contains the cement-mixing machines; others house the dynamos, a forge shop, drainage pumps, and workshops for repairing tools. The little locomotive shown is used for hauling material for the construction of the tunnel, the entrance of which is just beyond



FIG. 4. WORKINGS NEAR THE SULLY BRIDGE, SHOWING A DECAUVILLE LOCOMOTIVE.

the right of the picture, and also for removing the excavated materials to the river. The materials for construction are brought on boats, so as to cause the least inconvenience to traffic and the public. The cars drawn by the small two-ton locomotive are dumped into flat-



ENTRANCE OF THE TUNNEL AT THE PLACE VALHUBERT.

(Photographed from the interior, February 15, 1899.)

boats with sloping sides, which can carry 800 cubic metres at a load. The method of building the tunnel merits mention, for it seems practicable in all similar enterprises where it is necessary to work without making open cuttings. A metal shield sustains the rather thin layer of earth separating the level of the pavement above from the extrados of the tunnel arch during the progress of the work. This apparatus is pushed forward by hydraulic jacks at the rate of 1.1 metres in 40 minutes, and the masonry work follows it up at the same rate. At the time of the author's visit—in December, 1898—260 metres of this tunnel were finished.

On account of the heavy grade at the Place Valhubert, the rest of the profile is nearly level, its maximum grades not exceeding $\frac{1}{2}$ per cent., and the radius of curves being nowhere less than 150 to 200 metres. Since the rails are to be at the mean water-level of the Seine, it was necessary to build inverted arches at the bottom of the tunnel, to resist, in case of freshets, the upward pressures to which the work will be exposed. A central drain receives the infiltrations, and pumps at the lowest point of the line free the tunnel of this water when neces-

sary. That the stability of the various bridges along the route may not be affected, the line has been turned out to avoid their abutments. The general disposition of the works, excepting the uncovered portion along the Quai St. Bernard, falls into four types of cross-section. For the 900 metres between the Sully bridge and the Petit Pont the sur-based arch will have an opening of 9 metres, and will be built of masonry. For the 500 metres following, the layer of earth between the top of the arch and the roadway above being too thin for this construction, the cutting is covered with a metallic roof of 8 metres' opening (see Fig. 6).

In this stretch between the Petit Pont and the Pont St. Michel a station will be built, which, without doubt, will be largely used in the future by suburban passengers, since the line to Sceaux will also come in at that point. As a provision for this, the platform to be constructed there will have a length of 230 metres, to render access to the trains as easy as possible. Fig. 8 shows the foundations of the buildings which have been erected at this point, and also gives a general idea of the type of tunnel with metallic roofing.

From this point the type of all-masonry tunnel is again encountered, but, to save space for the future construction of a second tunnel, 8 metres wide, intended to carry the narrow-gauge Sceaux line from the Luxembourg to the Quai d'Orsay, the width of this tun-



VIEW OF THE OPEN CUTTING ALONG THE QUAI SAINT BERNARD.

this burned building, with solid walls and without any floors, increased the difficulties. As far as the d'Orsay barracks were concerned, their thinner walls were easily thrown to the ground. After four months, 30,000 cubic metres of material, among which were 10,000 of fine cut stone, which the contractors will use in the future constructions, were carried away, and on August 4, 1898, the works on the foundations were begun. There being no time to lose, the foundations of the d'Orsay station were finished in January, 1899.

The conditions of work, in view of the limited space (75 by 175 metres), the short time granted contractors for finishing it, and the clause which forbade them to interrupt traffic in the neighboring streets, rendered the task one of peculiar delicacy. It was impossible to begin excavations immediately in the quai for the placing of

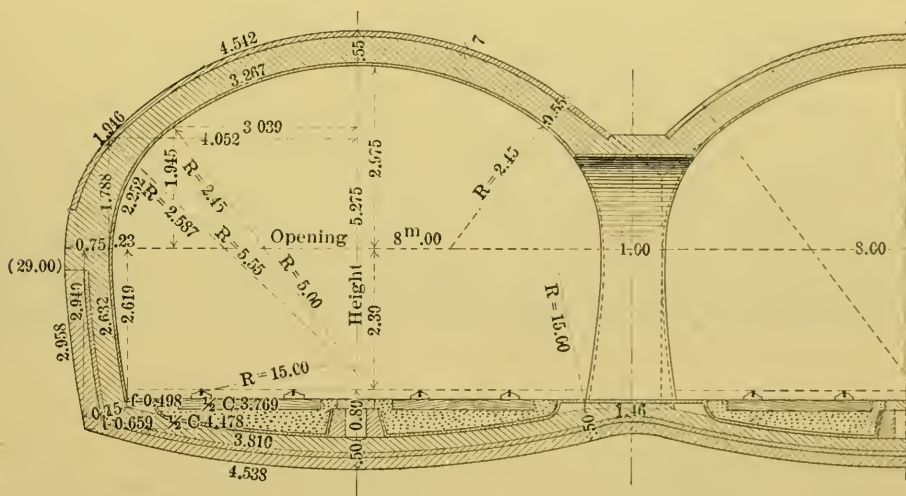


FIG. 7. CROSS SECTION OF DOUBLE TUNNEL BELOW PONT ST. MICHEL.

the metallic apron to be built along the new structures, on account of the main sewer of la Bièvre, which occupies the same place. It was necessary to wait until this had been diverted. These considerations require the construction of a subterranean passage, opening at the lower quai level on the Seine, and establishing from there a sort of communication with the interior of the workings. This gallery, through which is handled the material removed during the construction, is formed of two timbered passages, each 2.8 metres high and 3 metres wide, and each provided with tracks for the little cars drawn by a small Decauville locomotive, similar to that shown in the illustration of the Quai St. Bernard. The construction of these tracks required the cutting into the upper part of the main sewer for 1 metre. This necessitated the construction of a metallic apron sus-

tained by iron I-beams resting on the abutments of the arched roof of the sewer, which are vertical at this point. The flow continues normally, since the level of the water never reaches the height of this apron.

These preparations finished, and a fence having been built around



FIG. 8. TYPE OF CONSTRUCTION BETWEEN THE PETIT PONT AND THE PONT ST. MICHEL.

the site to keep out the public, work was begun simultaneously in five places. The plan (Fig. 10) shows the arrangement of these, and the illustration (Fig. 9) gives an idea of the condition of the work in December, 1898. The photograph was taken at the foot of the Rue de Bellechasse. At the first of these places the bucket excavator of the Couvreaux system, shown at work in Fig. 11, was put in operation, its efficiency being superior to that of the steam shovels which seem to be preferred in England and America. Using about 70 h. p., it handles 400 cubic metres of earth in 24 hours, and at the present time is working along the Rue de Lille side of the grounds. The excavated matters are dumped into cars running on track No. 1 (see Fig. 10), whence they are finally delivered to barges on the river. Their manipulation is not difficult, since the soil is composed of a first layer of alluvial earth 3 metres thick, below which is clay, beds of peat here and there, and sand at a depth of 5.5 metres below the street-level. The big broken stones seen in Figs. 9 and 11 come from the buildings which have been pulled down, and are to be carried away by the masons.

The triangular block (see Fig. 17) in the angle between the Rue de Lille and the Caisse des Dépôts et Consignations has not yet been disturbed. At present it is used as storage-space for the structural steel, most of which is furnished by Moisant, Laurent, Savay & Cie., of Paris, to be used later in the foundations of the new buildings.

The second workings are near the first. There the walls of the future station are going up on the Rue de Lille front. The width of this street will be increased from 10 metres to 16, and the space thus gained from the present street line will be vaulted over and used by the railway company as storage room. At this place the excavation, 5 metres wide and 7 deep, has gone on rapidly and easily, the foundations of the old barracks, which stood there, being scarcely more than 3.50 metres deep. On the site of the third workings work was by no means so easy, for here massive masonry of great ashlar reaches to a depth of 5.50 metres below the ground-level. In other places along the front of the quai, are encountered enormous masonry foundations, 2 metres wide and 2.50 metres thick, extending through the whole height of the work, and corresponding to the façade of the old buildings of the Cour de Comptes.

The fourth workings are also shown on the plan (Fig. 10). They are finished to the required depth, 5.50 metres below the level of the



FIG. 9. GENERAL VIEW OF WORKINGS AT THE QUAI D'ORSAY.

neighboring streets, and in them have been commenced the excavations for the foundations upon which will rest, through the intermediary of a layer of concrete* 20 centimetres thick, the steel frames of

*This concrete is made of 250 kilogrammes of cement to one cubic metre of gravel and one-half cubic metre of sand.

the ground floor of the future station. As these foundations are 2.50 metres below the level of the Seine, they have been invaded by water. Ditches have been run from them to a central cistern, which is kept clear by six pumps, in continuous operation. Three of these pumps are worked by hand and three by electricity, the current being generated by dynamos driven by a 20-h. p. traction engine in the shed *g* (Fig. 10). At the height of the platforms of the station a course of 4 centimetres of neat cement will be laid in all the masonry work, this impervious layer being intended to cover all the walls of the lower story, so as to prevent any infiltration of water that might, without reference to freshets in the river, produce pressures upon the structure. In this connection the work has been superbly done, the revetment actually surpassing that of the Suresnes dam in thickness by 2 metres.

The fifth workings are on the lower level of the quai. There a new landing is being built, the walls being 3 metres further out than those of the old structure. In this place the work is carried on under conditions very difficult for the men engaged upon it, who are constantly in mud despite the pumps, on account of their nearness to the river. Upon this wall will rest a steel framework, the large bays of which will serve both for the ventilation of the station and the lighting of its interior.

As the work goes on at all the workings, both day and night, numerous incandescent and arc lamps have been installed, as well as a few acetylene burners, furnished with reflectors, and several Wells lights burning heavy oil. These last give most excellent results, and, for equal light, cost much less than the electric lamps. The work

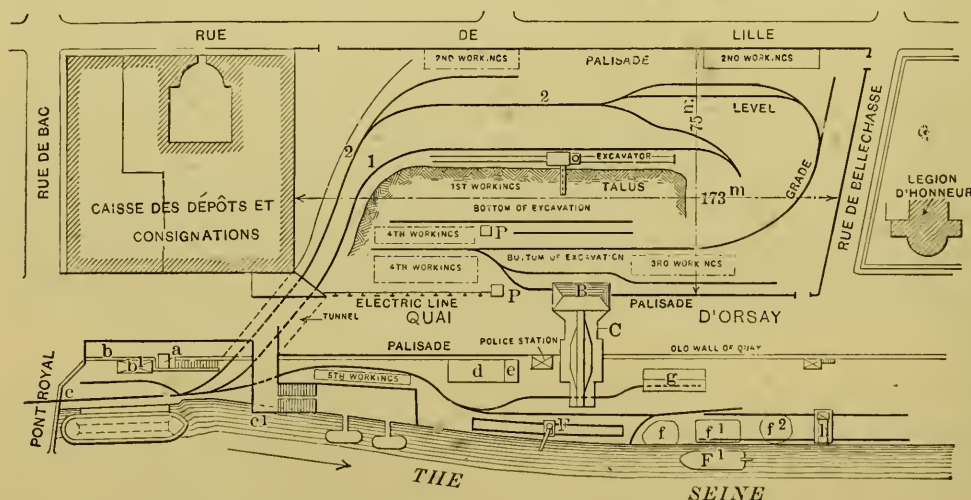


FIG. 10. PLAN OF THE WORKINGS AT THE QUAI D'ORSAY.



FIG 11. COUVREUX EXCAVATOR AT WORK.

done at night approaches in amount that executed in the daytime, but the number of men engaged is very different. The first shift consists of scarcely 100 men, while the second ranges between 300 and 325. It is almost an achievement, and one upon which the engineers in charge should be congratulated, that all this activity, confined to its narrow limits of space, has not in any way interfered with traffic.

It is well to indicate at this point certain of the general arrangements which have been carried out. The excavated materials are removed from the work by means of one hundred and twenty dumping cars, hauled either by horses or Decauville locomotives, one of which is of 2 tons', and the other two are of 5 tons', weight. The plan (Fig. 10) shows very clearly the temporary tracks, of 0.60 metre gauge, which have been laid through the workings. The lines marked No. 1 and No. 2 extend to the provisional gallery, which passes under the quai and empties at *c*, and where the materials are dumped on flat boats. Referring still to the plan, *b* shows the repair-house for these cars, and *a* the office of the contractors, MM. Brissot, Peraglie, and Rigault. The carpenter shop is shown at *b*. Construction materials, cut stone, gravel, sand, etc., arrive by boats on the river. A 6-ton steam crane, *F*, or a floating elevator, *F*₁, of 5 tons' capacity, discharges them at *f*, *f*₁, *f*₂, and the traveling crane, *h*, allows them to be distributed along the lower level landing. The

GARE DU QUAI D'ORSAY

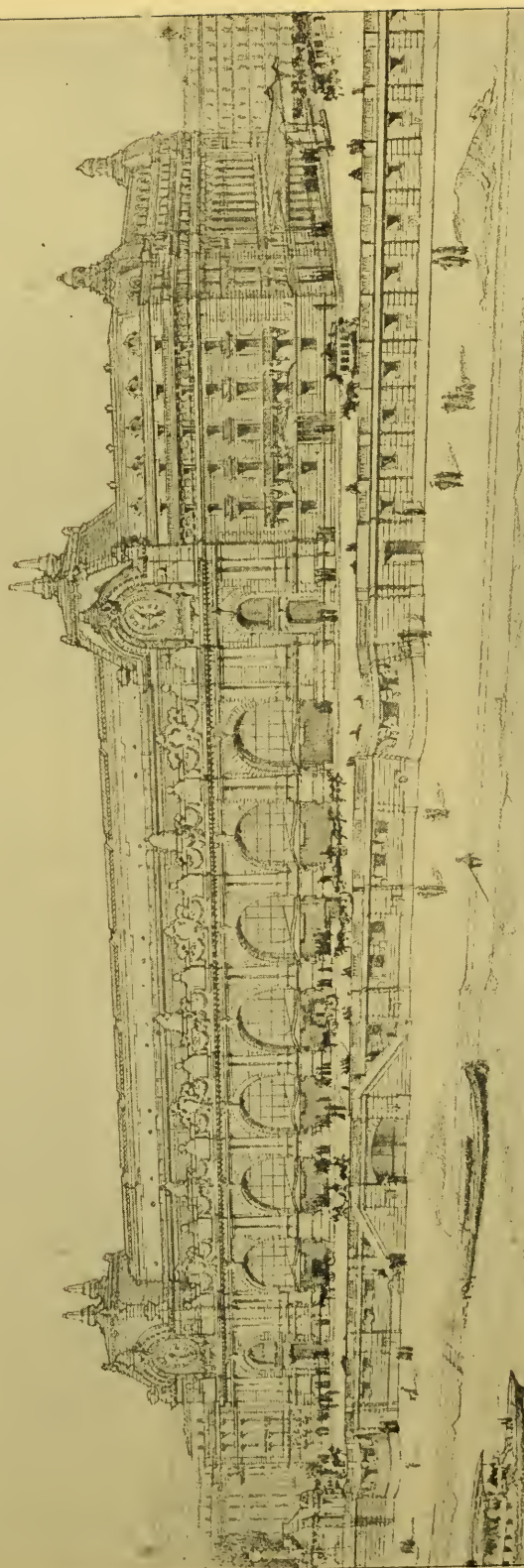


FIG. 12. THE QUAI D'ORSAY STATION, FROM THE ARCHITECT'S DRAWING.

scaffolding, which is 6 metres high above the quai, connects the works separated by the wooden fence. The crane handles the materials, which the dumping cars carry back to the concrete-mixer, *B* (seen also in Fig. 9.) This mixer makes 75 to 100 cubic metres of concrete per day. Portland cement is stored in the shed, *d*, and in the building, *e*, is the tool repairing shop.

This is the present state of the work. Looking now at the future constructions, it may be said that the new d'Orsay station will not be



FIG. 13 THE UNDERGROUND OUTLET FROM THE QUAI D'ORSAY TO THE LANDING.

View beneath the Pont Royal, showing the barges for the removal of earth; the Pont Solférino in the distance.

an industrial edifice alone. Its able architect, M. Laloux, has endeavored, with success, to make the artistic part, which was confided to his hands, harmonize with the remarkable monuments surrounding its situation,—the Louvre, the Pavilion of Flora, one of the most beautiful buildings of the old Imperial Palace, and, a little further away, the Tuileries Garden and the Place de la Concorde, without counting the more modest, but very handsome, building of the Legion of Honor, on the same site. The sketch of his design (Fig. 12) shows that he has most worthily accomplished his desire.

The arrangements for train service, designed by M. Sabouret, engineer of the Orléans company, are equally well conceived. The rails come in at 5 metres below the ground line, and the station therefore comprises two levels. It occupies the site where formerly

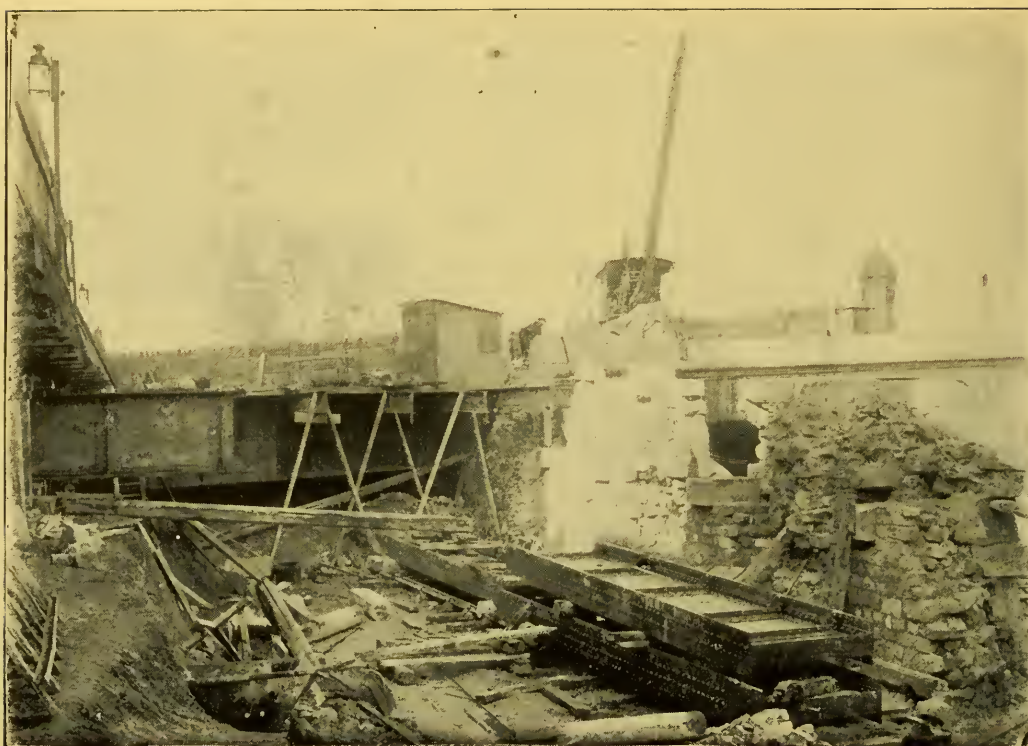


FIG. 14. CONDITION OF WORKS ABOVE THE PONT ROYAL, FEBRUARY 15, 1899.
The railway is to pass under the structure of wrought beams, which contains a water main.



FIG. 15. GENERAL VIEW OF THE WORKS ON THE QUAI D'ORSAY, FEBRUARY 15, 1899.
The main piers of masonry are seen above ground, and the columns to support the metal floor of the station are being placed.

stood the barracks and the Cour des Comptes and the narrow street which separated them. Its form is that of a rectangle about 200 metres in length and 75 metres in width. In the basement (Fig. 17) there are fifteen lines of track accessible to trains, and one on the side of the Rue de Lille,—a single-service track, not in direct communication with the principal lines. The tracks are so situated that any may be used for incoming or outgoing trains. With a view of assuring the regularity of the service, they have been arranged in the following manner. The three tracks nearest the Seine are used for shunting empty cars, and waiting trains. The four tracks nearest these are used for outgoing express trains; upon the next two are handled the suburban service trains, incoming and outgoing. The next two receive the incoming express trains, and, finally, the four

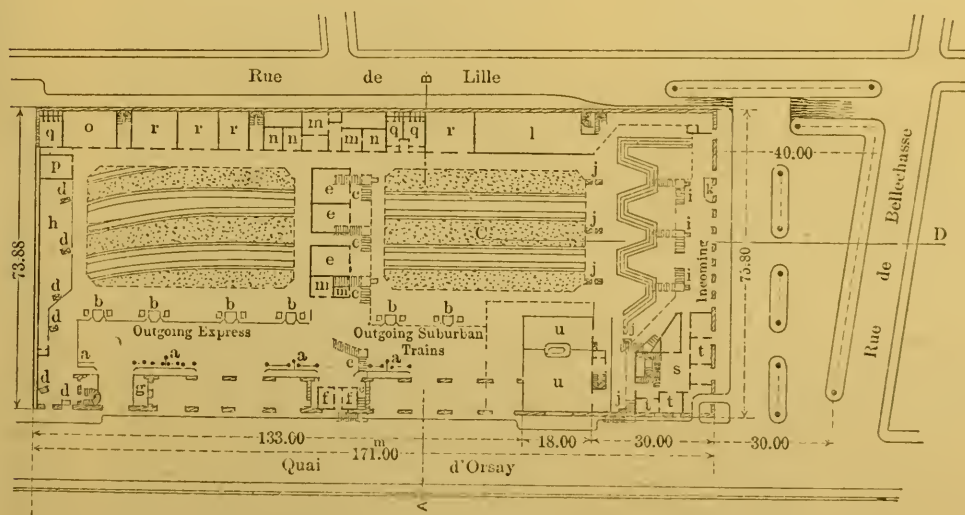


FIG. 16. PLAN OF SECOND FLOOR OF THE NEW QUAI D'ORSAY STATION.

remaining tracks are used, two for suburban trains and two for shunting tracks. Access to the trains will be had by platforms 6 and 7 metres wide and from 185 to 240 metres long. They will be raised to a height of 85 centimetres above the level of the rails, thus permitting the traveler to enter the cars on a level, without ascending or descending steps. Two of the platforms (marked on the plan "for trucks") will be given over to the railway employees, for handling baggage-trucks, lamps, grease-cans, and other necessary service utensils. At the right-hand end of the plan are shown a number of turn-tables, which will permit the turning of the locomotives of incoming trains, the engine being able to go out by one of the free tracks and to be placed at the head of an outgoing train. By reason of the switches on the first five tracks which run into the dead-ends, passing under

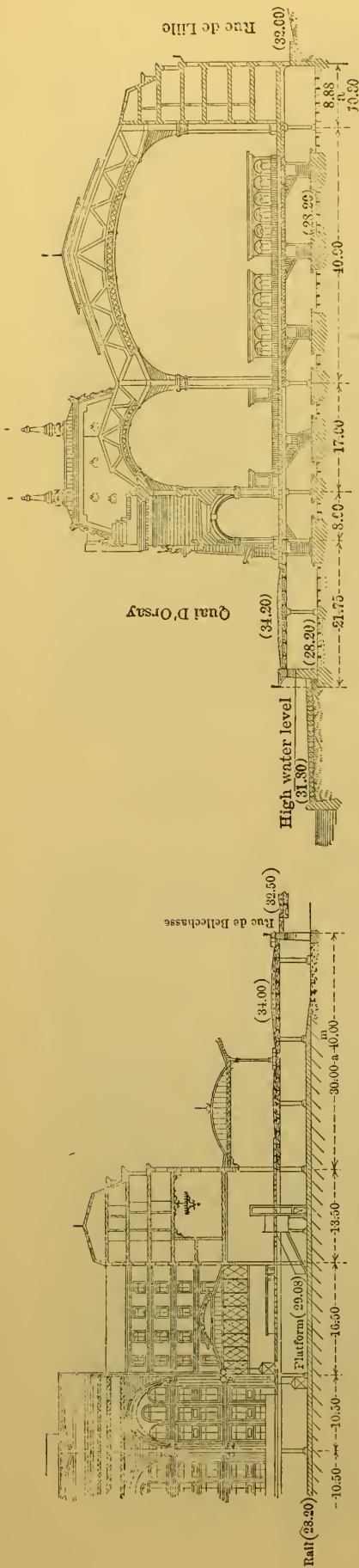
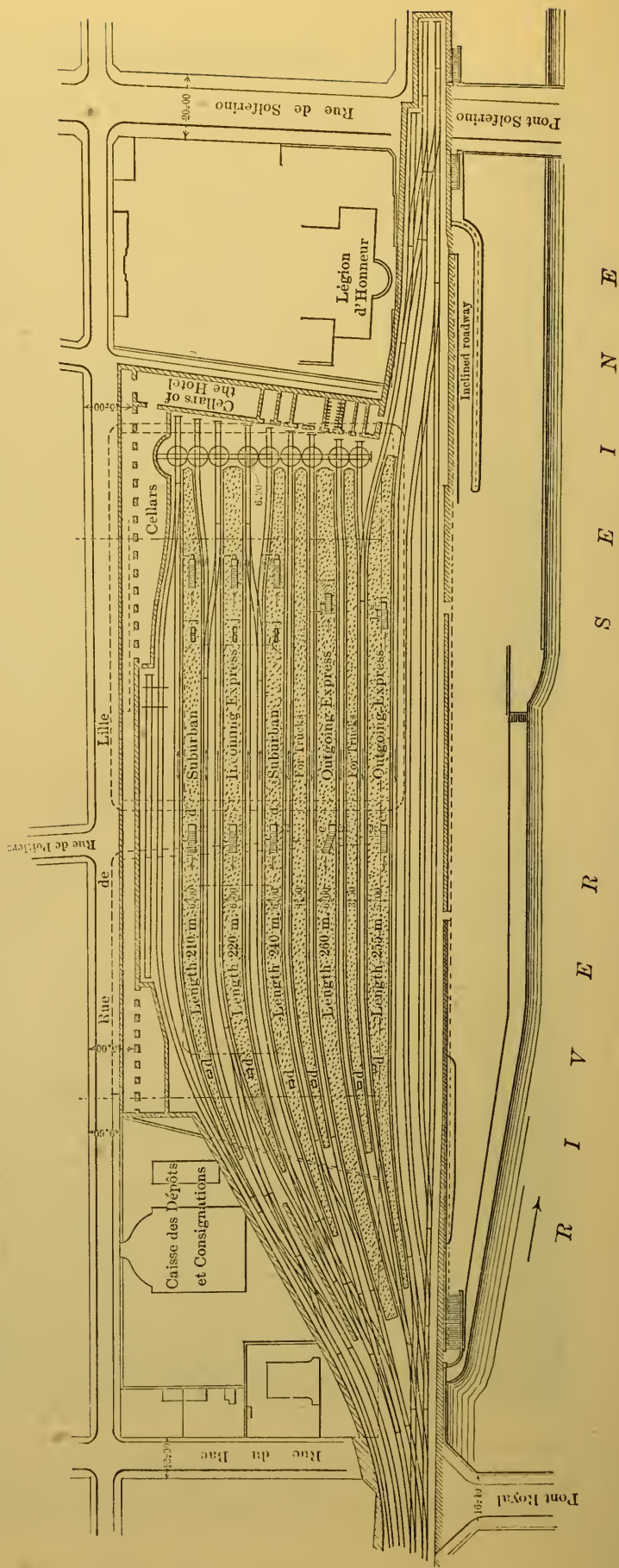


FIG. 19. CROSS SECTION OF THE NEW STATION.



the Rue de Solferino, a locomotive can be detached from its train when in the station, and sent back without being turned around.

On the second floor (Figs. 16, 18 and 19) the approaches are arranged so that, for express trains, as well as for the suburban service, departing passengers go in on the Quai d'Orsay side, and arriving passengers come out through the narrower Rue de Bellechasse.

Space has been saved by not establishing the customary courtyard for cabs and vehicles. By the provision, all along the buildings, of a gallery 4 metres wide, a vast covered sidewalk has been made, avoiding the standing of cabs, etc., in groups.

At the entrance to the station, in the vestibule, are the ticket offices and luggage-register rooms, shown at *a b*, Fig. 16. The luggage is sent down by the elevators, *d j*, without interfering with the circulation of passengers, who, in their turn, go up and down by the staircases, *c c*, serving each platform.

Incoming passengers are kept separate from those leaving the city. On coming out of train, passengers go out by the bottom of the station, where the staircases and the elevators, *i*, conduct them to a vestibule situated in the interior court on the Rue de Bellechasse side. Finally, since the company's service will utilize only the first story, they have given over the part of the building toward the Rue de Bellechasse for a hotel.

The total of expense required by this prolongation of the Orleans railway line will reach approximately the following figures, taken from the estimate of M. de la Brosse:

Preliminary service and fees of the personnel.....	900,000 f.
Purchase of real estate and indemnities paid to the Caisse des Dépôts et Consignations.....	12,300,000 f.
Works; substructure, diverting water- and gas-pipes, telephone wires, sewers, etc.....	17,550,000 f.
Superstructure; comprising the construction of the St. Michel and d'Orsay stations.....	9,250,000 f.
Total.....	40,000,000 f.

Since the length of the line from the Place Valhubert to the Quai d'Orsay is, in round numbers, 4 kilometres, this amounts to 10,000,000 francs per kilometre—a figure which, without doubt, holds the record. Will the increased traffic compensate the company for its sacrifices? That is a question for the future.

THE DEPRECIATION OF PLANT, AND ITS RELATION TO GENERAL EXPENSE.

By H. M. Norris.

FORMER articles have dealt with the general bearings of depreciation of plant upon manufacturing costs, and the special application of the principles to drawings, patterns and tools. It remains to treat the concluding items of my classification of the inventory which, it may be recalled, was : A. Standard drawings; B. Standard patterns; C. Standard machinery and tools; D. Special tools, jigs and fixtures; E. Line shafting and accessories; F. Office and shop fixtures; G. Belting; H. Miscellaneous.

"Line Shafting and Accessories," item E, is easily dealt with. It includes nothing but shafting, hangers, and couplings—all pulleys being charged directly to the machine whose countershafts they drive, provision for the recording of which is made on the back of the pages in the Standard Plant Ledger, illustrated in Fig. 1, of the previous article. The cost of erecting a line of shafting is an outlay that cannot be appropriately charged to either Capital or General Expense. It must go to Preliminary Expenses, together with original surveys, plans of buildings, legal expenses, and other kindred items incident to the incorporation of a new company, the writing off of which should be done as rapidly as the profits of the business will allow. In fact, profits are not earned until this debt is cancelled, although it need not necessarily be met, during the first year or two, such a measure often being too severe a burden on the founders, as well as a handicap to the business in general. It can be paid off gradually by applying a certain part of the surplus earnings each year,—say, everything over six per cent,—until extinguished.

With the exception of journals,—the renewal of which goes, of course, to general expense,—a properly-erected line of shafting deteriorates much more slowly than any other kind of plant. Leaving out the question of second-handedness, its depreciation may be said to be practically nil. Hence the rate at which this item may be written off is very low. Some firms combine it with their building account, and depreciate both at the same rate. A rate of 3 per cent. will usually be found sufficient. This will bring a value of \$1,000 down to \$466.97 in twenty-five years, and to \$218.06 in fifty years, which is as far ahead as most of us need look,

"Office and Shop Fixtures," item F, possesses little value as second-hand plant, and should, in consequence, be depreciated liberally. In this classification is included all office and drawing-room furniture, tool-room cabinets, stock-bins, tool closets, men's lockers,—the fittings, in fact, for the entire works. It may be contended that some of these items deteriorate much more rapidly than others, and that, for this reason, the classification is not consistent with good practice. So they do. An office desk, will, for instance, last many times as long as the ordinary work-bench; but, when it is considered that the latter must always be kept in good repair (another general expense charge) in order to produce creditable work, as well as to maintain the appearance of the shop, and to avoid the demoralizing influence which a dilapidated bench has upon the men, the category will not appear so broad. But in some very large shops, where an annual revaluation, or comparison of old figures, cannot be made without considerable labor, it may be expedient to separate the various articles into a number of sub-divisions, grouping each according to its respective rate of depreciation. One must be careful, however, to guard against the danger of over-classification.

Mr. Lewis carries seventy distinct accounts in his General Monthly Journal, among which are such items as "Postage and Telegrams," "Cleaning Offices," and "Staff Refreshment Allowance." Divisions so minute may be very necessary under some circumstances, but are not required in the average shop, employing from one to two hundred men. It may be very gratifying to one's idea of propriety in regard to detail to know just what every kind of outlay amounts to in the course of a year, but the information is not necessary for inventory purposes. The articles are not valued with the object of fixing a selling price, but in order to learn by what amount the assets of the preceding year must be raised or lowered.

"Belting," item G, is often classed in the same category with rapid-wearing plant, such as small loose tools, portable forges, wheelbarrows, etc., but, if any considerable degree of accuracy is sought, it is better to treat it individually, not as a whole, but by separating the belts into three general groups, i. e., G. 1, Cone Belts; G. 2, Shifting Belts; G. 3, Non-Shifting Belts.

I have seen belts of the first group give out in less than three weeks, while others last twenty-five years. The D. I. & E. Greenwald Company, of Cincinnati, is using a 6-inch cross-belt of this class on one of its boring mills, which has driven the machine for thirty years. This, however, is a very exceptional case. Economy demands

that a belt shall be consigned to the scrap-heap in its early stages of decay. This does not mean in ten years, or even in twenty years, but so soon as it shows any material lessening in usefulness, be it in one year, or fifty years.

Belts of the second class are variously estimated as possessing from two to five times the length of life of cone belts, while those of the third group last longer than either of the others. I recently examined a 4-inch heavy single oak-tanned belt which, after fifteen years of continuous service, did not appear more than half worn out. It was a horizontal "shifting" belt, used to drive the countershaft for a 26-inch lathe, and, except for a slight amount of surface cracking, seemed perfectly good. I also saw an 18-inch double "non-shifting" belt which, after forty years of almost continuous running, looked in fit condition to fulfil its duties ten years longer.

Problems of depreciation of belting are confined, in one sense, within a narrower field of uncertainty than those pertaining to the depreciation of machinery, and are consequently somewhat less difficult to deal with. There is, of course, a greater element of danger of loss from accident with belts than with some other plant, but, outside of this one risk, the question is a simple one, as nothing but life need be considered.

Mr. Fred W. Taylor says, in his *Notes on Belting*,* that the life of a belt depends upon:

(1) The material from which the belts are made, and the method of their construction;

(2) The means of fastening and tightening them on the pulleys, i. e., whether laced, spliced, or fastened with hooks;

(3) The care and regularity with which they are greased, and whether they are kept clean and free from machinery oil;

(4) The general nature of the service which the belts are called upon to perform;

(5) Whether the belts run vertically or horizontally;

(6) The relative length of the belts;

(7) The relative speed;

(8) The tension under which they are run; and

(9) The average total load to which they are subject in working.

Mr. Taylor's experiments covered a period of nine years, and were conducted with sufficient care to enable him to form some very reliable conclusions, the most pertinent of which is:

* Presented at the New York meeting, (December, 1893) of the American Society of Mechanical Engineers, and forming part of Vol. XV., of the *Transactions*.

Double leather belts, when treated with great care, and run night and day at moderate speed, should last for seven years, when under average total load of 111 pounds per inch width, or 385 pounds per square inch. They should last for eighteen years when under average total load of 54 pounds per inch width, 174 pounds per square inch section.

In his summary of results, he gives the percentage of belts still in use after nine years of continuous service as 100 per cent. Between forty and fifty belts were used in the experiment, of which number not one was worn out, the shifting belts looking nearly as good as new. To use his own words:

I think it would be safe to say that the life of the shifting belts will be three times that of the cone belts. The cone belts have reached a point at which it is doubtful whether it pays to repair them, while the shifting belts are, to all appearances, in almost as good condition as when they first went into use, and should last twice as long as they have already.

Continuing, he says:

It is interesting to note that, after 8.8 years of life, the total cost of maintenance and repairs of the shifting belts amounts to only 30.4 per cent. of the original cost, while with the cone belts the maintenance and repairs through a life of 6.7 years amounts to one and one-half times the first cost.

If it is true that a double belt will last seven years when run day and night under an average total load of 111 pounds per inch of width, and eighteen years when under average total load of 54 pounds per inch of width, it ought to last twelve and one-half years when run day and night under average total load of $82\frac{1}{2}$ pounds,—the mean of the two figures used by Mr. Taylor,—which, in my judgment, more nearly represents the average load in the average shop. Twelve and a half years, however, can be taken only as the average life of all belts, while it has been shown that shifting belts will last about three times as long as cone belts. Hence their respective lives are represented by two numbers, the larger of which is three times the smaller and the mean of which is $12\frac{1}{2}$,—that is, by $18\frac{3}{4}$ and $6\frac{1}{4}$ respectively. Twenty-four hours per day is equivalent to 168 hours per week. If the belts are run only 60 hours a week, instead of 168, their life will be lengthened in the proportion of 168 to 60, which will give $52\frac{1}{2}$ years in the one case and $17\frac{1}{2}$ years in the other. These figures seem very high, and, if accepted at all as a basis of calculation, should, in prudence, be reduced by a factor of safety of, say, 100 per cent., bringing them down to twenty-five years and eight years respectively.

Since worn-out belting has no scrap value, its original cost must be extinguished within a certain period. This means that it must be depreciated by some other system than by writing off a percentage annually from its diminishing value, which, though showing a con-

stantly-decreasing worth, would never entirely eliminate the belts from the books of the company. If cone belts be assigned a life of eight years, and shifting belts a life of twenty-five years, the cone belts should be depreciated by one-eighth their value the first year, and to three-quarters their cost the next, and the shifting belts by one-twenty-fifth the first year, and to twenty-three twenty-fifths their cost the next, etc. This record may be very easily and satisfactorily kept in conjunction with the plant inventory book, in which each set of belts is distinguished by the number of the machine which the belts drive; any error in writing off will thus force itself on the attention of the manager, or whoever is responsible for the accuracy of the balance sheet.

"Miscellaneous," item H, is the next and last category on our list. It covers all such plant as cannot be appropriately charged elsewhere, as, for instance, land and buildings, which although not intended to be included in this discussion, should receive a word in passing. Land occupied by a manufactory is not apt to depreciate in value, the tendency being rather toward an increase, which frequently runs far beyond its original cost. It is only in case of change of ownership, therefore, that a revaluation of site is usually found necessary. Buildings, on the other hand, may depreciate very rapidly, the term of life depending upon their design and solidity of construction, the material of which they are made, the quality of the workmanship, the climate, the usage to which they are subjected, and the thoroughness with which they are kept in repair. Buildings of brick and stone, subject only to deterioration from ordinary usage, may be written off very gradually, a rate of from one to two per cent. generally being sufficient. But, in the case of a building put to rougher usage, as, for instance, a foundry or smithy, a rate of four per cent. will be found more appropriate. Buildings of wood and iron require a still higher rate,—five to ten per cent. not being excessive in some cases. As a general rule, however, an average rate of two per cent. for a brick or stone machine shop, four per cent. for a brick or stone foundry, six per cent. for ordinary iron buildings, and eight per cent. for wooden buildings, can be taken as fair, where repairs are properly looked after and are paid for out of revenue.

The effects of depreciation at these rates, including, also, that of 10 per cent. of each original \$1,000 for terms of years advancing by steps of ten years up to one hundred, is shown in the following table, which, it is thought, will be found of assistance in the selection of appropriate rates for various types of buildings.

DEPRECIATION AND GENERAL EXPENSE.

81

EFFECTS OF DEPRECIATION OF EACH ORIGINAL \$1,000 AT DIFFERENT RATES, FOR TERMS OF YEARS.

YEARS.	2%		4%		6%		8%		10%	
10	817	07	664	83	538	62	434	39	348	68
20	667	61	442	00	290	11	188	69	121	58
30	545	48	293	86	156	26	81	97	42	39
40	445	70	195	37	84	16	35	65	14	78
50	364	17	120	88	45	33	15	64	5	15
60	297	55	86	35	24	42	6	79	1	80
70	243	12	57	41	13	15	2	95		63
80	198	65	38	17	7	08	1	39		22
90	162	31	25	37	3	81		65		08
100	132	62	16	87	2	05		28		03

The great diversity in rates of depreciation for the several distinctive types of assets enumerated in the foregoing will, I think, make it appear advantageous to deal with each group or classification individually by some such method as that outlined. Such division of capital not only simplifies the work of determining a fair valuation for partially-worn plant appraised for the first time, but affords one a much better opportunity of gaining in accuracy with each new readjustment of rate. For example, suppose that, after six years of service, it were found that the cone belts were not more than half worn out, and that, owing to a particularly dull year, the business showed a loss, which the directors wished to make good from the surplus earnings of other years. It would be an easy matter to change the rate to a one-twelfth reduction per year, and entirely permissible to consider the difference in value as profit—provided, of course, that everyone interested thoroughly understands from what source this additional capital is derived. It is often advisable to establish a high rate of depreciation for this very reason, as the amount set aside for wear and tear is, in one sense, a reserve fund, although in stock companies it is seldom wise to call it by this name, lest the share-holders should demand its distribution as dividend.

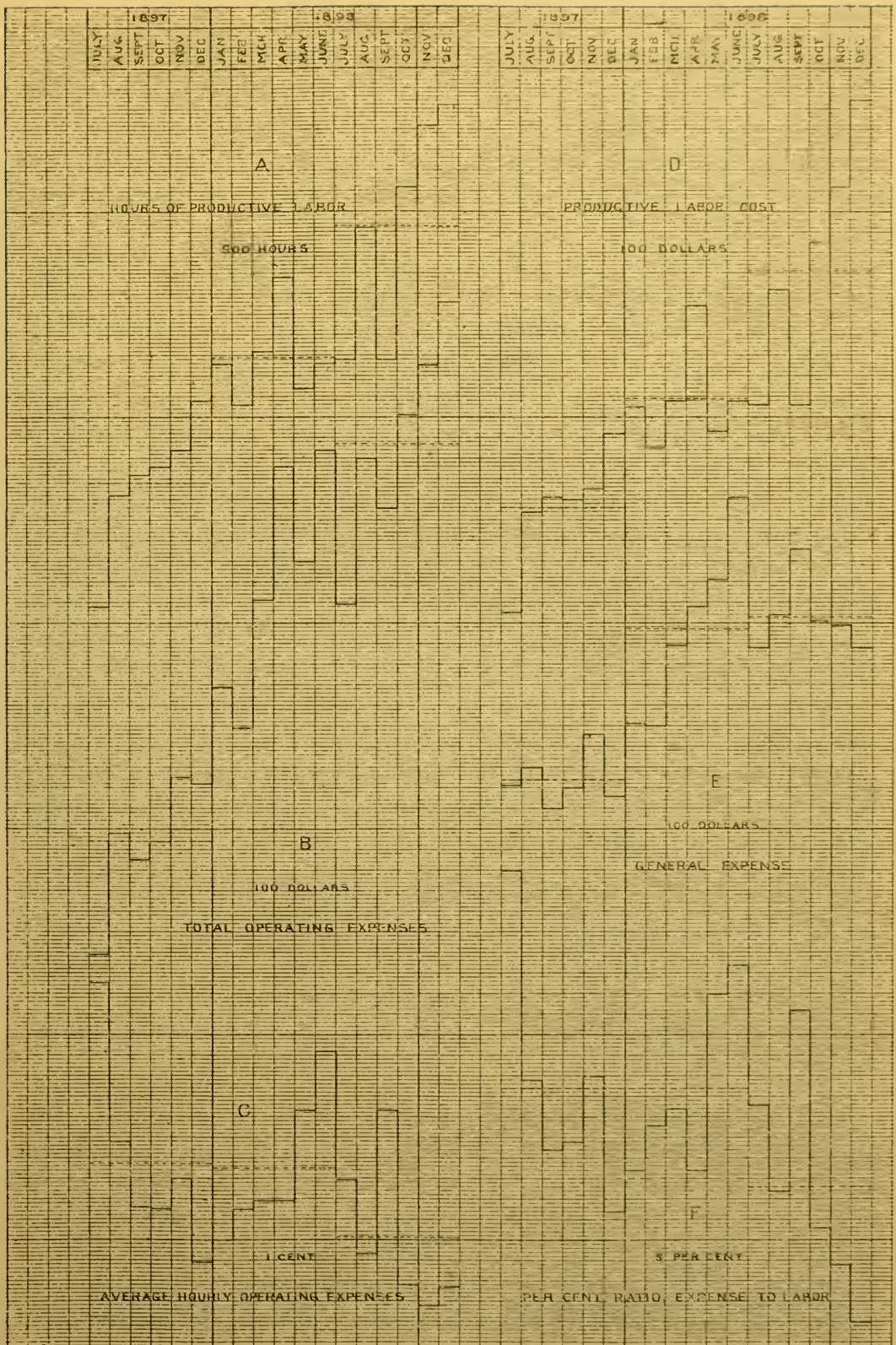
This brings us to a general consideration of the Expense Account, shown on page 394 of the December issue, the use of which form will now be patent to everyone. "Interest and Deterioration," item R, represents the results of the preceding year's inventory, and "Interest on New Assets," item S, the interest for the remaining months of the year on all outlays chargeable to Capital, the month upon

which report it appears. If a plant is valued at \$150,000, and past records show that \$15,000 per year is a fair amount to allow for deterioration, it is obvious that profits will not begin to accrue until \$22,500 has been made over and above all actual disbursements—\$15,000 for loss from wear and tear, and \$7,500 to pay interest on the capital investment, making $R \ \$22,500 \div 12 = \$1,875$ per month. General expense is not met, therefore, until this sum has been fully provided for. This may be done in a variety of ways, the most common of which is the "Per Cent. Ratio" plan. Of this question, however, we shall speak later.

These reports are made out monthly, as explained in my first paper, after which the totals are converted into diagrams, or "curves." Unless one has a special aptitude for analysing a mass of complicated figures, it is very difficult to grasp the full meaning of comparative statistics without employing some method of diagrammatic notation to represent values. They are easily and quickly drawn, and may be read by the dullest of minds, the general tendency of the business, whether of growth or decline, being evident at a glance. They also show any unusual fluctuations that may occur from time to time.

In order to illustrate the enormous advantage which may be derived from the use of diagrams, I give on pages 83 and 85 the complete genealogy of the cost per hour of work made by my company from the time I took hold of the works in July, 1897, to January, 1899. The vertical divisions represent months, as shown at the top of the pages, while the horizontal divisions indicate hours, dollars, cents, or percentages, as the case may be. The small figures beneath the diagrams give the scale of each, or the reading between heavy lines,—i. e., the equivalent of every five fine divisions. Thus it will appear in Diagram A that the number of hours was increased 12,200 within the period from July, 1897, to January, 1899. The figures directly under the months show the percentage of over-time during each month, and the figures under them the number of working days in each. Over-time is given in actual hours, but is paid for at the rate of "time and quarter time," which fact should be kept in mind in making comparisons.

Columns 1, 2, and 3 exemplify each a distinctive method of figuring costs, and in column 4 the results are brought together for comparison. A shows total hours made by all producers; D, the total amount of wages paid producers; E, the total amount of general expense. Diagram B is the sum of "Productive Labor Cost," D, and "General Expense," E, which divided by "Hours of Productive La-



GENEALOGY OF MANUFACTURING COSTS.

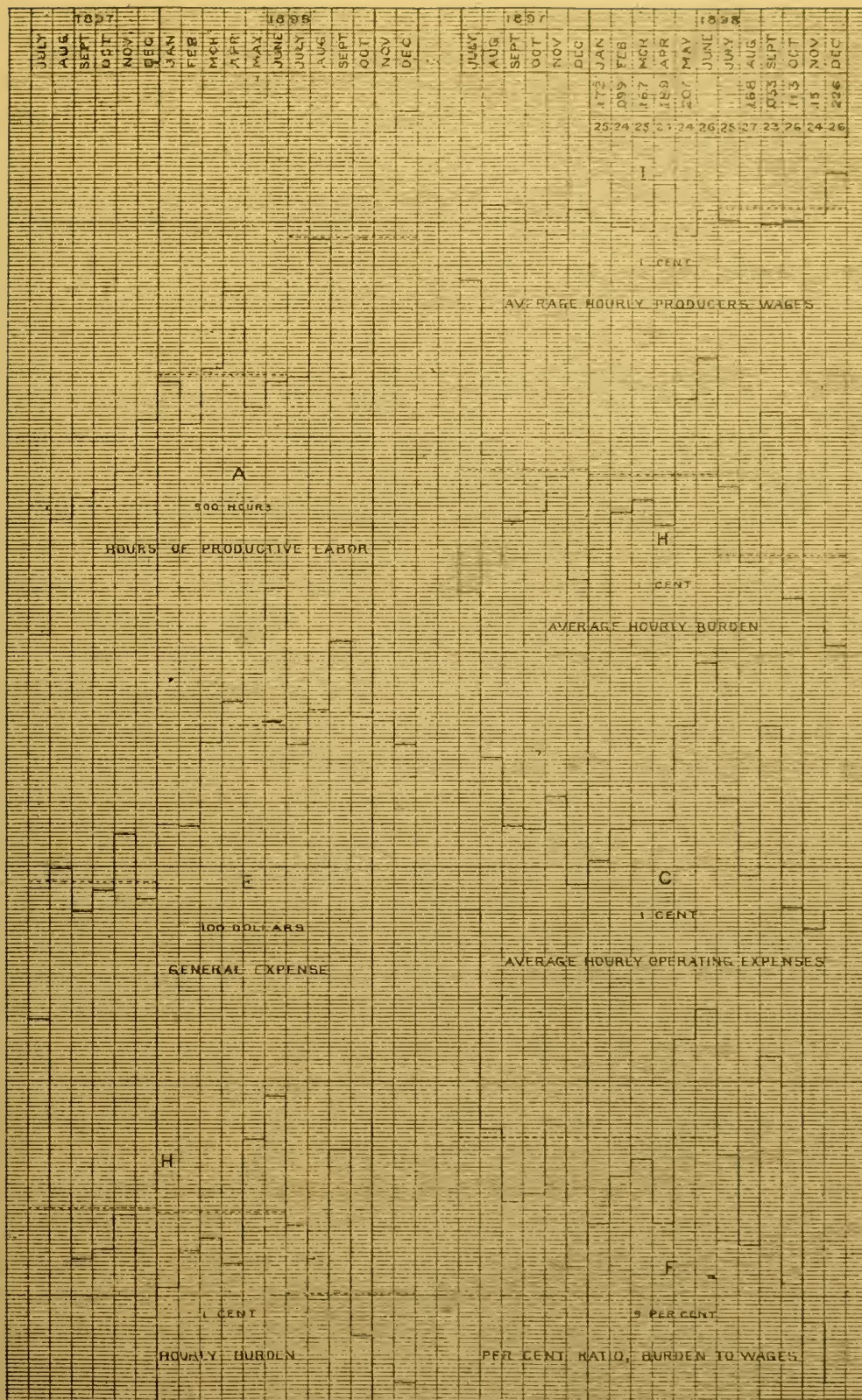
bor," A, gives the "Average Hourly Operating Expenses," C. Diagram F represents the results derived by dividing "General Expense," E, by "Productive Labor Cost," D, and shows the relation of Expense to cost of productive labor, while Diagram H is based on the figures obtained by dividing "General Expense" by "Hours of Productive Labor," and gives the relation of Expense to hours of productive labor.

There has been much discussion of late in regard to the relative merits of these three systems. Each plan has its advocates, and each is opponents. Which shall we accept as the fairest method of apportioning expense? The diagrams show the equivalents in each system. Thus, the month that General Expense was 82.87 per cent. of wages, the Average Hourly Operating Expense was \$.3189, and the Hourly Burden \$.1445. These figures furnish a definite and thoroughly reliable basis of calculation upon which to pass judgment, and, to my mind, answer the question at once. General Expense cannot be allocated to different orders by different methods. The plan that is used for the man must be used for the boy. Hence that system is best which, other conditions being equal, gives the fairest hourly charge for both high-priced and low-priced labor.

Suppose a workman whose rate is 30 cents an hour took 10 hours to do certain work; at what rate per hour must his time be charged, by the three systems, in order to make 20 per cent. profit on the job? What, also, would be the charge per hour, were his rate of wages only 5 cents an hour?

1.	\$.3189	+ 20 per cent.=	\$0.3826	cents per hour.
2.	.30 + .1445 + 20	" =	.5334	" "
3.	.30 × 1.8287 + 20	" =	.6583	" "
4.	\$.3189	+ 20 " =	\$0.3826	" "
5.	.05 + .1445 + 20	" =	.2334	" "
6.	.05 × 1.8287 + 20	" =	.1097	" "

It must be borne in mind, in examining the above figures, that, no matter which system is adopted, the ultimate results are **always** identical. To multiply total hours made by producers in any period by the average hourly operating expenses for that period, which, in our illustration, is \$.3189, is the same as adding its equivalent, or \$.1445, to the hourly wages of each, or to increasing the wages of each by the other equivalent of 82.87 per cent. It is wholly a question of fairness of distribution of the General Expense Account. By the "Fixed Rate," or so-much-per-hour, plan,—lines 1 and 4,—the work-



GENEALOGY OF MANUFACTURING COSTS.

man's time would be billed at the rate of \$.3826 per hour, regardless of his rate of wages; by the "Hourly Burden" plan,—lines 2 and 5,—at \$.5334 or \$.2334 per hour, according to his wages,—30 cents or 5 cents per hour; and by the "Per Cent. Ratio" plan,—lines 3 and 6,—at \$.6583 or \$.1097, depending upon the same conditions.

Custom has established a maximum rate of 60 cents per hour for the ordinary run of light work, beyond which one cannot go without risk of losing trade, except by special agreement. If, therefore, we can keep within this figure without the loss on either a high or low scale of wages, it is obviously best to do so. It is manifestly wrong to rate a man at the same figure as a boy, and equally unfair to charge 55 cents (difference between lines 3 and 6) an hour more for a man's work than a boy's, when there is a difference of but 25 cents in their relative rates of wages.

It will be noted that the figures furnished by the "Hourly Burden" plan—lines 2 and 5—come midway between those derived from the "Fixed Rate" and "Per Cent Ratio" plans,—lines 1 and 4, and 3 and 6, respectively,—which fact, alone, is, I think, a sufficient argument in favor of the superiority of the "Hourly Burden" plan.

The reading and comparison by means of diagrams of statistics pertaining to one's business is interesting in the extreme, and I regret that space does not permit an analysis of those shown in the illustration, the reliableness of which I can vouch for. Suffice it to say that, with such a set of diagrams before him, a manager can tell pretty nearly what is going on around him. He sees, for instance, by the dotted lines in Digram I, that, notwithstanding the marked fluctuations that occur from month to month, the average hourly wages for the six months ending June 30 are the same as the average for the preceding period. He knows, however, that wages are higher than they were a year ago, and that the averages could not be equal without a corresponding decrease in some other direction,—i. e., by the employment of a larger percentage of cheaper men, made possible by the more extensive use of jigs and fixtures. He turns to diagram A, and finds an increase of 3,050 hours between averages for these two periods. This increase in number of workmen should, he argues, show a proportionate decrease in fixed charges. He examines Diagrams H and F. The first shows a falling off of two-tenths of a cent; the second, nothing at all. With an increase between averages of \$530 in cost of wages,—Diagram D,—the per cent. ratio should, under ordinary circumstances, have grown considerably less. Why has this saving not been effected? He looks at Diagram E, and

notes the rapid climbing up of the general expense account in the months from March to June. This does not please him. He had hoped for better results, despite the heavy expense he had been obliged to incur in the rearrangement of the shop during this period. He resolves to be more cautious the remaining portion of the year. He traces every leakage to its source, institutes such reforms as seem expedient, and watches every outlay with renewed vigor. The results are gratifying—the Hourly Burden, Operating Expenses, and Per Cent. Ratio, for the last six months, all showing a very decided falling off.

At the close of the year the twelve monthly reports are merged into one, showing the total outlay for each category of assets. These are then added to the depreciated value on the preceding year's report, as illustrated below, and the inventory taking, so far as the plant itself is concerned, is completed, which, I believe, is as far as I am expected to go.

CLASSIFICATION.		1897	%	D. V.	1898	TOTAL.
A	Standard Drawings . . .	4,000	10	3,600	1,500	5,100
B	Standard Patterns	6,000	15	5,100	2,000	7,100
C	Standard Machinery } and Tools }	30,000	8	27,600	10,000	37,600
D	Spec. Tools, Jigs and } Fixtures }	3,000	5	2,850	1,150	4,000
E	Line Shafting and } Accessories }	1,000	3	970	120	1,090
F	Office & Shop Fixtures.	800	5	670	130	800
G	Belting	1,200	15	1,020	280	1,300
H	Miscellaneous Plant . . .	500	10	450		450

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

AS has been explained, forest sawing, or green sawing, as it is sometimes called, is in Europe a less important process in timber-converting than it is in the United States. Log sawing is carried no further than the reduction of timber to merchantable shape by removing the surplus wood and waste, so that the balks and deals will be in suitable form for transportation and for re-sawing at the timber yards, where they are reduced to finished dimensions as wanted.

This is, in several respects, a rational way of proceeding, which will, no doubt, be introduced into the American continent when timber becomes scarcer and dearer than it is now, and when the market and methods of selling are adjusted to such a system. The advantages are that the timber is not injured in transportation by breakage or exposure, and can be handled at half the cost when proper tackle is employed; there are no grit, dust, and season cracking to contend with, and the re-sawn timber can be furnished to customers bright and clean, and with accurate dimensions. Deals, which seems to be a name for any kind of squared pieces whose section is a parallelogram, form a unit from which two-thirds of common lists can be cut out with but little waste, as is proved by the small amount of *débris* found about saw mills in European cities.

It is commonly assumed that any sharp wood-cutting implement driven by steam power will displace enough shavings or sawdust to supply fuel for the power consumed, but this depends in a great measure upon circumstances. A coarse or thick saw may do this, but a thin one will not, especially when cutting slowly and accurately; but, setting aside rules, it is obvious that the waste of timber is measurable by the *débris* or offal in any kind of a wood-working establishment.

It may be remarked here, as a further digression, that furnaces for burning the dry *débris* from wood-working establishments are usually operated in a wasteful manner by attempting to control the fires, or the amount of steam generated, by the rate at which the fuel is supplied to the fires. This is not the best manner, or the most

economical one. The furnaces should be kept full of fuel, and the rate of combustion should be regulated by a damper. This dispenses with a great amount of care,—not always exercised, however—otherwise required in order to keep a regular supply of steam; it also avoids bare grates,—a common means of balancing the spasmodic effect of shovelling light fuel into a furnace under full draught.

A strong draught is required to open up the fires in case of choking, also in burning wet sawdust; but the draught should be continually under control, and its full force should be employed only in emergencies. It is an advantage in burning small *débris*, such as sawdust and fine shavings, to place on the grates a layer of re-

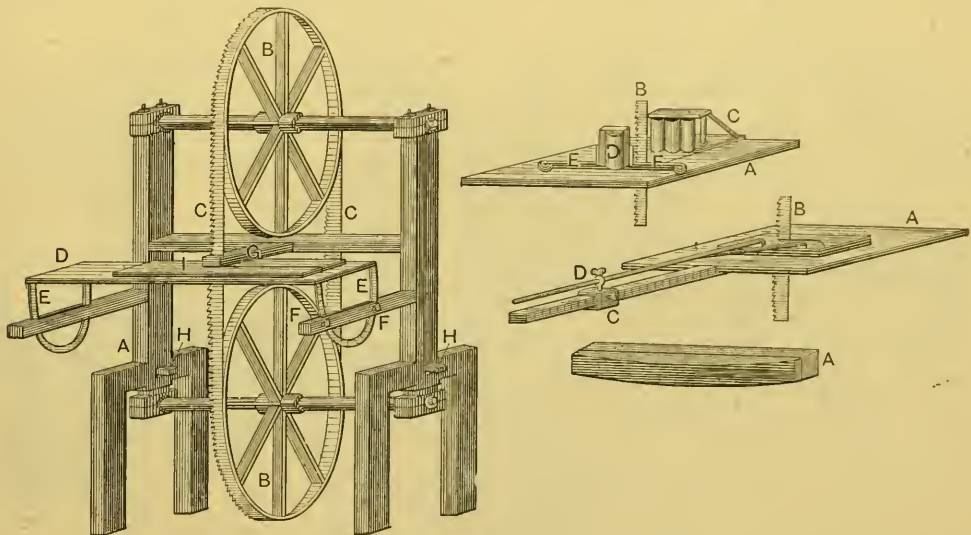


FIG. 1. THE FIRST BAND-SAW MACHINE.
(Patented by William Newberry in 1868.)

Has tipping table for sawing bevels, and feed rolls and radius gauge, showing a complete grasp of the capabilities of the invention.

fractory stone, broken into pieces small enough to prevent the unburned fuel from falling through the grates. These stones become red-hot, and serve to ignite fresh fuel, after the manner of a bed of live coals, and are no impediment to clearing the grates.

The characteristics of European log-sawing machines are, in most cases, massive framing; provision for sawing crooked timber; thin saws and slower feeding; a more careful support of saw plates of all kinds; and a wide use of machines for dressing saws.

The thickness of a saw is to a great extent determined by its size, or length, and this is governed by the dimensions of the logs to be sawn. The writer, on first visiting timber yards in northern Europe, could not get rid of the impression that the round timber was all

culls or waste. A raft load of logs in the Gotha river in Sweden was thought to consist of telegraph poles. It happened to be a collection of small timber even for there, and a visit to the Pacific coast of North America, soon after, still further emphasized the enormous difference in the timber resources of the two countries. Soon after arriving in San Francisco there was encountered in the street a squared beam of fir more than a hundred feet in length, being hauled to a factory in course of erection. Following this beam to its destination,—a woolen factory then being built,—it was a matter of astonishment to find all the longitudinal beams, or “stringers,” of the same length. This astonishment was increased when the contractor said: “We never bother about dimensions, and just order what

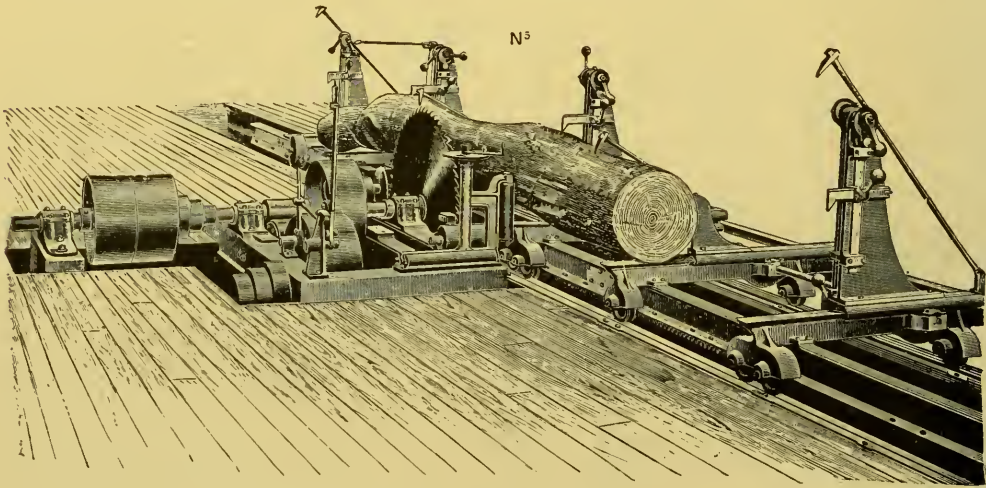


FIG. 2. FOREST SAWING MACHINE

An adaptation of the American circular mill, but of heavier proportions and adapted to irregular lumber, such as shown. These machines are intended to be taken to the woods to saw the lumber where it is cut.

we want.” A section eight feet in diameter, cut from a redwood tree, completed a new impression of American forest timber.

The illustrations in this chapter show, in several cases, logs being sawn, and these will serve as common examples of the hardwood timber found in European yards. Considering such diversity as this in the material to be operated upon, the distinction in machines, disclosed in the drawings, will seem trivial.

The care of saws, mentioning as a distinguishing feature of European practice, is a refinement. For twenty years past there has been but little use of files for this purpose. About twenty years ago there were invented and put in use various modifications of machines for sharpening saws, both straight and circular, that saved a good deal in the expense of sharpening; but this was not the chief end attained.

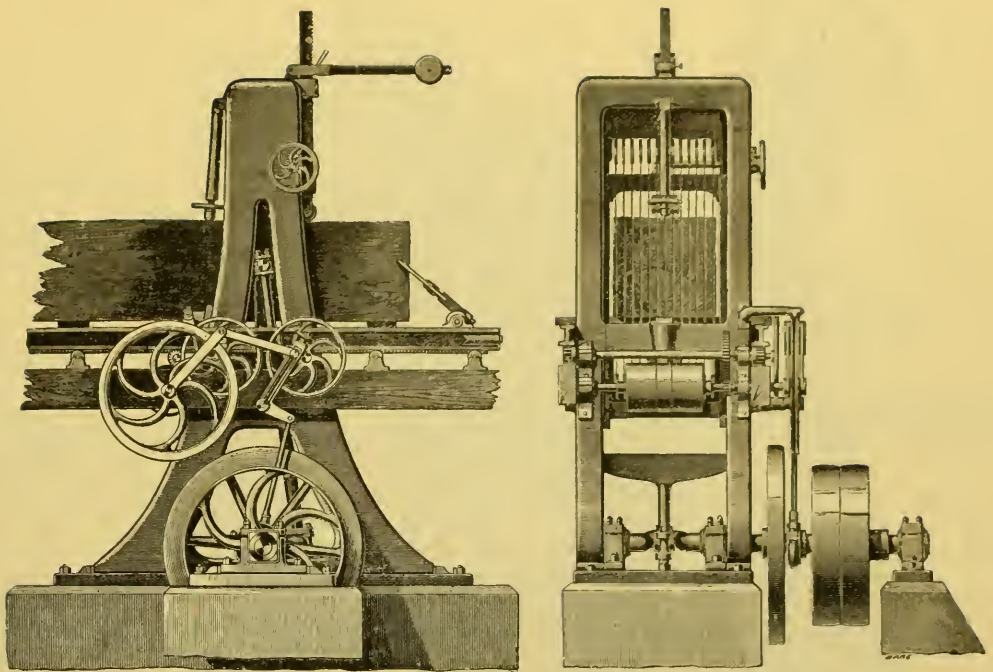


FIG. 3 GANG SAWING MACHINE.

Standard gang sawing machine with carriage outside the main frame, and with friction rack feed. Adapted for sawing bunks or squared logs.

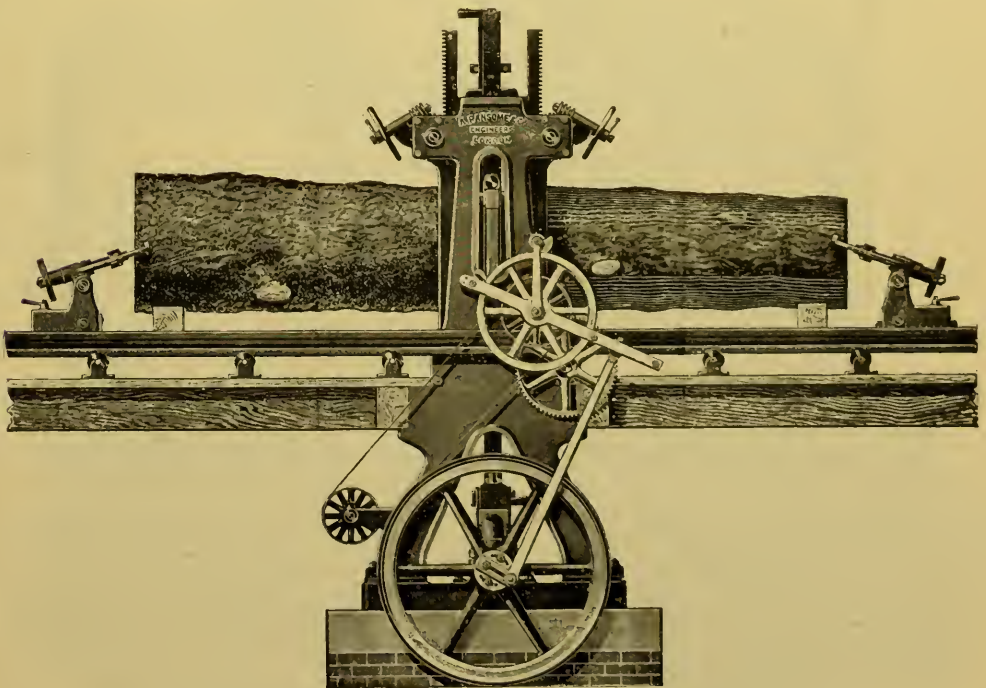


FIG. 4. LARGE GANG SAWING MACHINE.

A heavy gang sawing machine with carriage and rack-and-pinion feed and top bearing rollers.

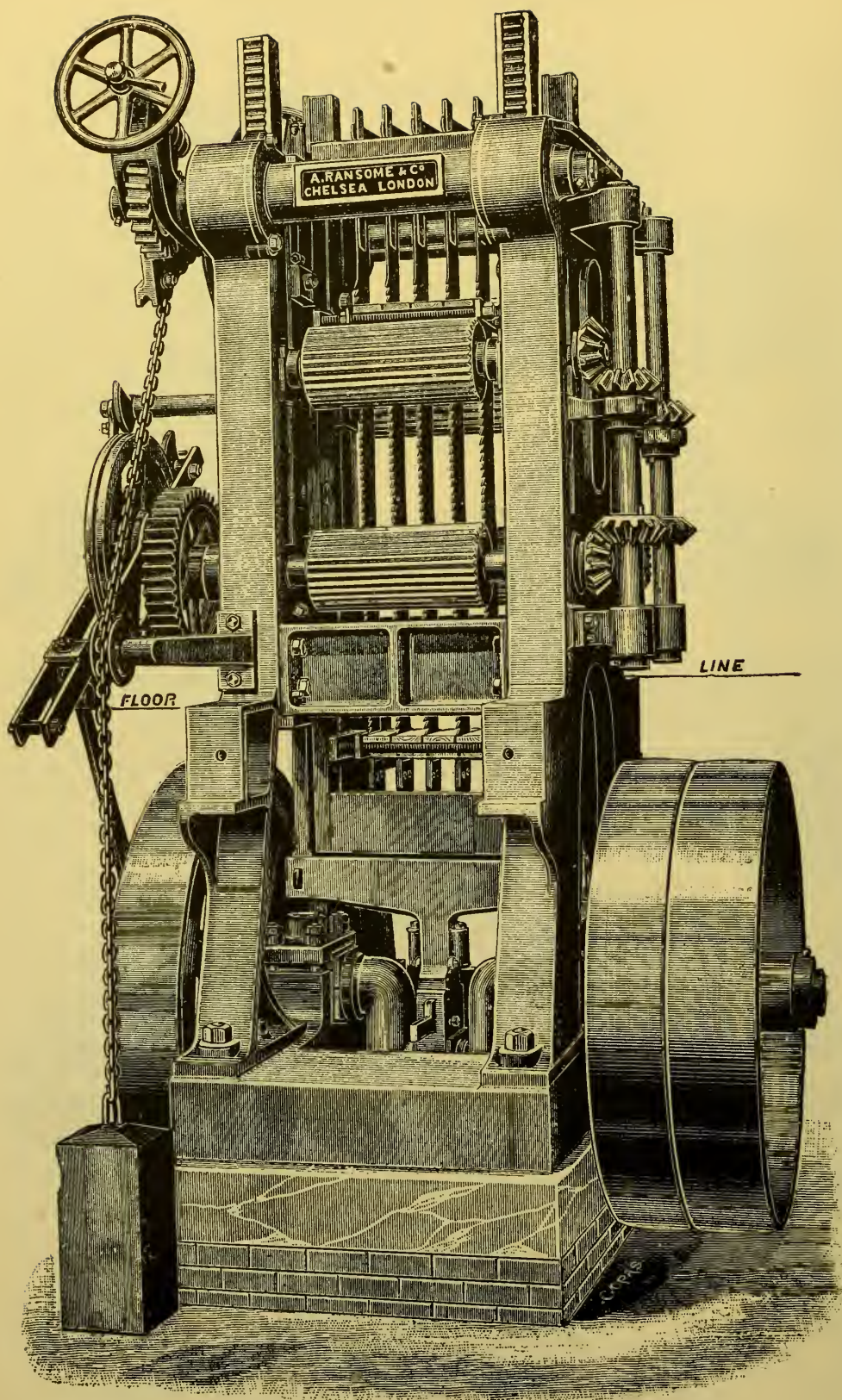


FIG. 5. DOUBLE-ROLLER GANG SAWING MACHINE.
Both upper and lower rollers are driven, thus furnishing a powerful feed. The centre crank shaft is of forged steel, and all parts are well proportioned and heavily built.

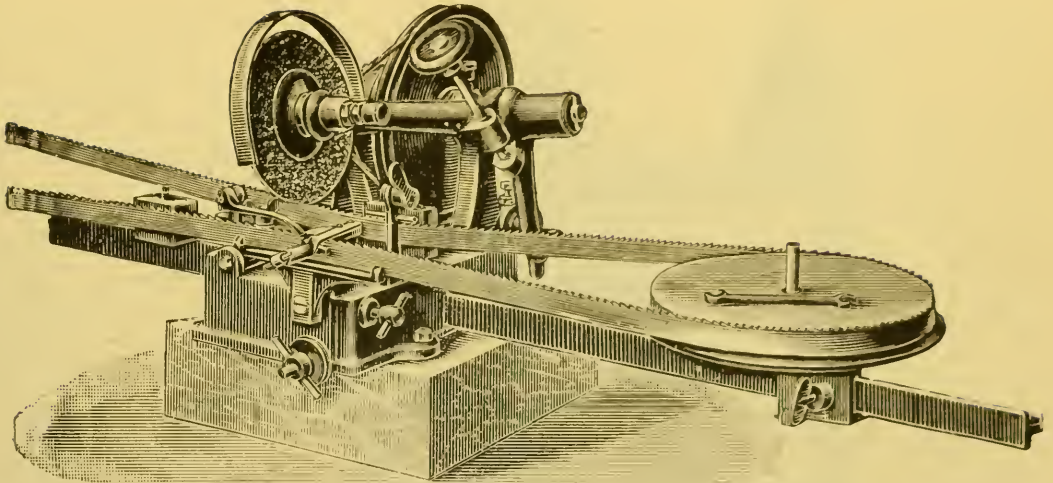


FIG. 6. AUTOMATIC SAW-SHARPENING MACHINE FOR WOOD CUTTING SAWS HAVING STRAIGHT TEETH.

Adaptations of the machine are arranged for circular and gang or frame saws.

The main thing was the truth of the saws, which divided the work equally between the teeth.

It would be difficult to convey in words an idea of the difference in working between a saw that is perfectly round or straight and one that is not. A sawyer knows by the "feel," the moment a saw touches the wood, whether the teeth are true. The sound is different; so also is the result; and even the greatest care in hand-filing will not produce an effect like that of machine-grinding, because the teeth are separately dressed, depending on sight, and re

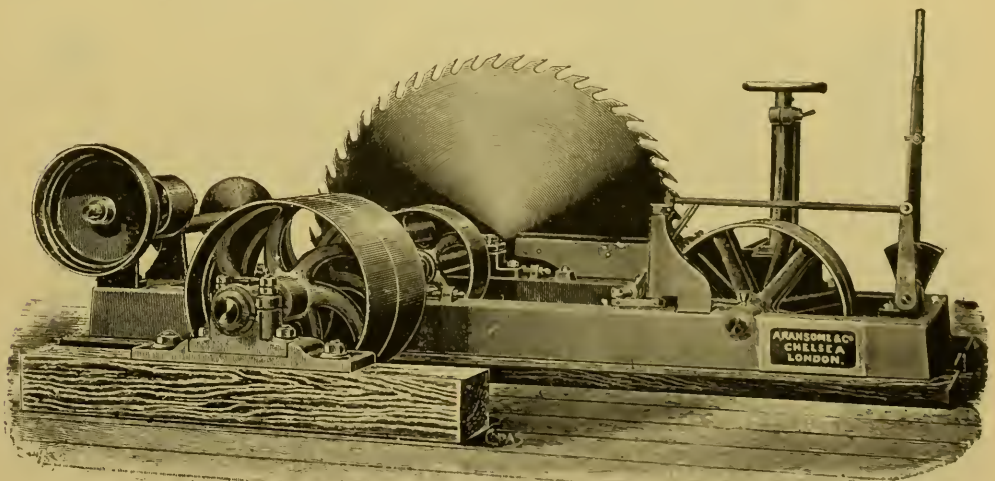


FIG. 7. CIRCULAR SAWING MACHINE FOR LOGS.

A combination of the European 'rack saw' and the American 'circular sawmill.' The packing boxes are shown along the front side of the saw.

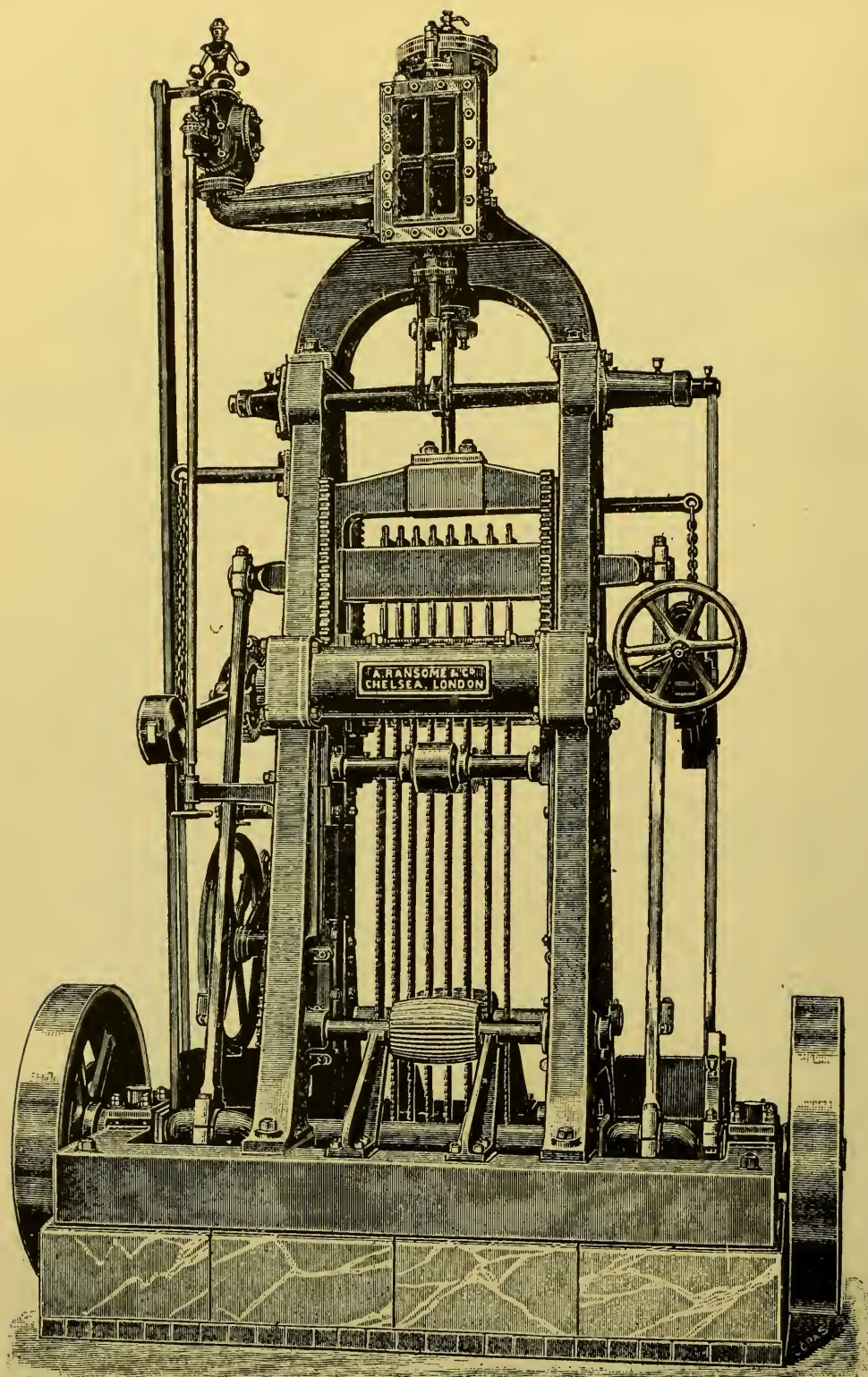


FIG. 8. DIRECT-ACTING GANG SAW MACHINE.

The frame carrying the gang saws is operated directly by the steam cylinder above, the stroke being controlled by the crank-shaft below. There is a roller feed, and the machine is self-contained and adapted for erection anywhere.

quire frequent jointing, or grinding off of the points, while the saw is in motion.

The steel thus wasted is commonly a good deal more than that consumed by the wear of cutting, so that half the cost of saws is lost; besides this, hand-filing is commonly done at the points of the teeth alone. The gullets, or spaces between the teeth, soon become too shallow to hold the sawdust, and the saws require "gumming"—formerly done by punching out between the teeth, which left the saws with inherent strains and frequently with cracks.

The grinding of saw teeth with emery wheels is no doubt extensively practiced everywhere now, but the filing process continues to a great extent where machines would be much better. Such machines, when well made and provided with the required adjustments, cost a good deal, but, when the waste of files and of the steel lost in jointing is taken into account, it is seen that the cost of a good machine is soon saved.

So much has been already explained respecting the importance and manner of re-sawing timber in European yards that but little remains to be added, except illustrations of the machines; and even this requires but little in the way of explanation or remark, because

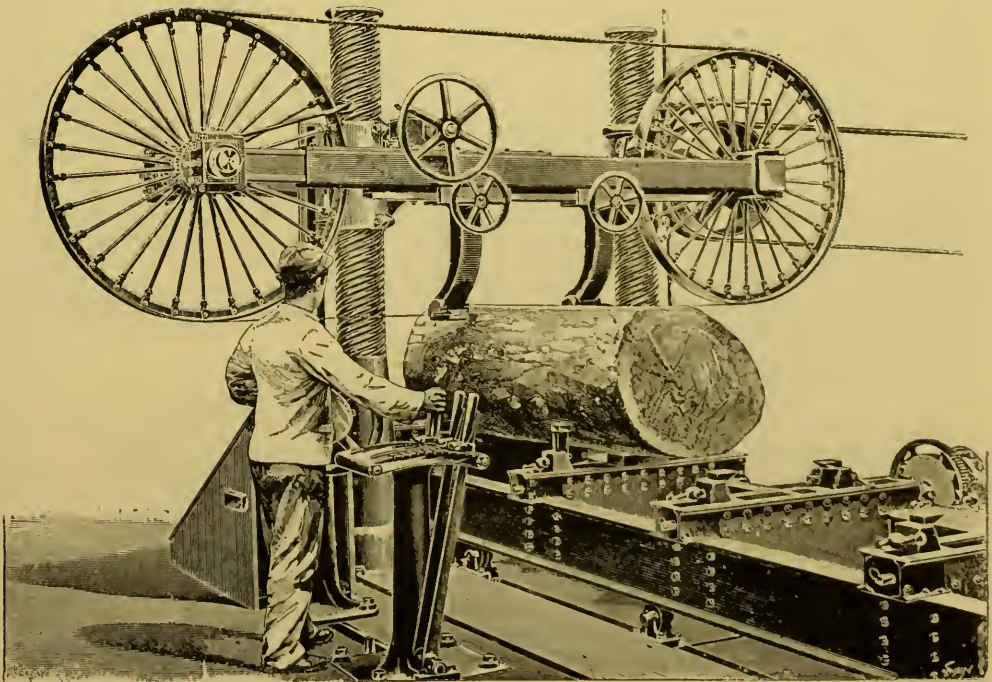


FIG. 9. HORIZONTAL BAND-SAWING MACHINE.

A unique form of machine of doubtful advantage—the whole machine being moved for adjustment, instead of the log. The horizontal position is not favorable to the best action of the saw.

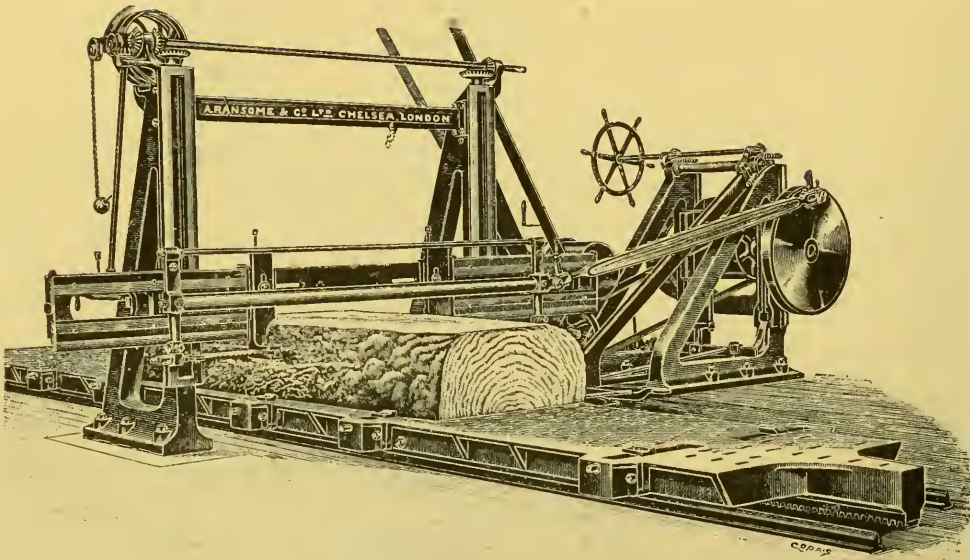


FIG. 10. HORIZONTAL SAWING MACHINE FOR LOGS.

Designed for reducing logs of fine wood at a slow rate, but not so well adapted for this work as is the band saw.

the machines in common use are practically of one type—light gang saws adapted to run at high speed.

Such machines are the result of "natural selection," free from complication, quickly adjusted, and, when the number of cuts or kerfs are three or more with a single machine, or four to six with a

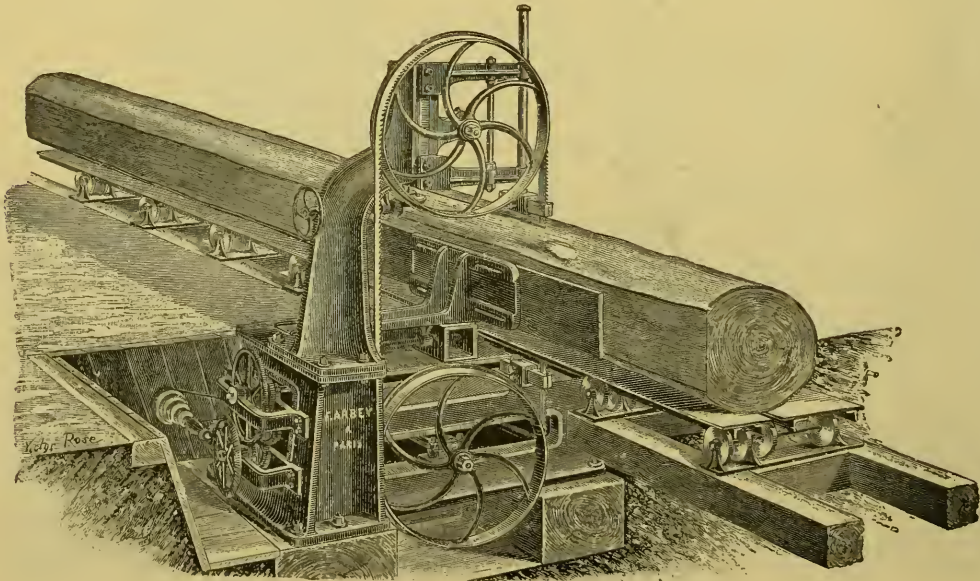


FIG. 11. BAND SAWING MACHINE FOR LOGS.

An example of early French practice, peculiar for its split-rack carriage and gauge plate, and illustrating the type of machine built in France for use in South America, etc.

double machine, the speed of performance is such as to meet all the requirements, economic and other, that arise in practice.

The gang of saws can be changed from one dimension to another in a few minutes, and, when there are several machines available, as is common in the larger timber yards, a list of "stuff" can be cut out as fast as it can be measured or counted and loaded on wagons.

With the equilibrium type of machines having two saw frames that move oppositely, the speed can be from 350 to 400 strokes per minute, which, with only four saws, gives a cutting movement of the

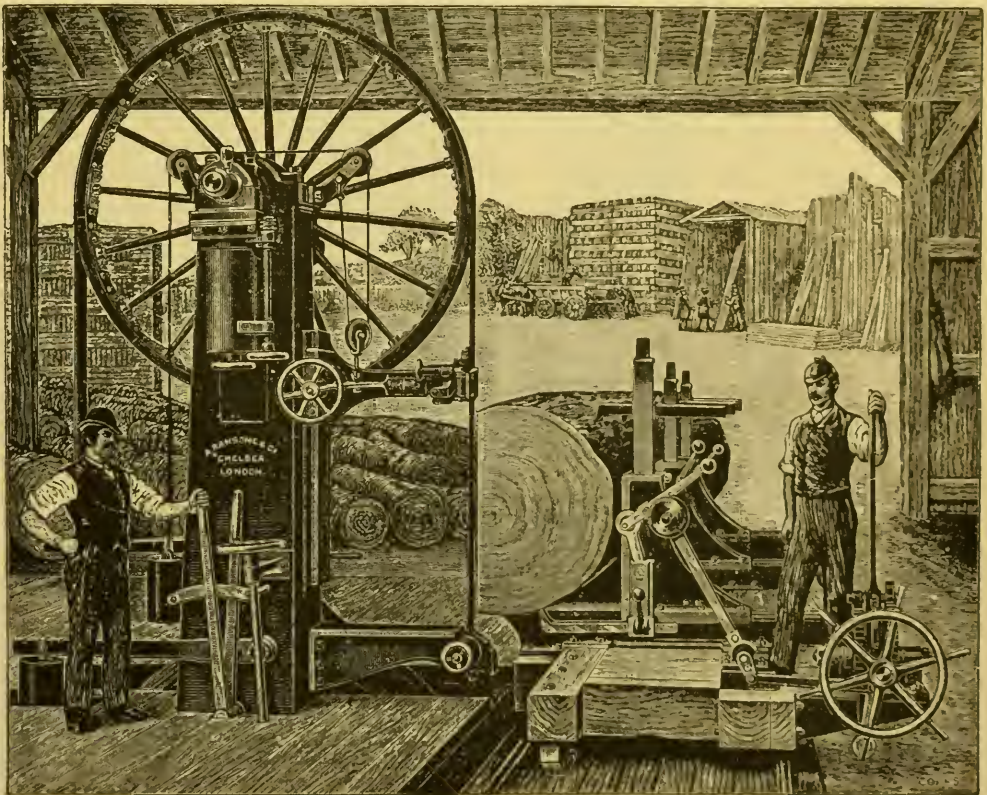


FIG. 12. LOG BAND SAWING MACHINE.

One of the most complete log band mills built in England, closely modelled after American designs, and representing good English and American practice.

teeth equal to a thousand feet per minute. Both circular and band saws are employed in re-sawing, but not to a great extent. The evolution of the latter, which has taken twenty years or more in the United States under what may be called "high pressure effort," has not proceeded so fast as in Europe, where the timber is more obdurate and experiments are more dreaded.

Why reciprocating re-sawing machines, or deal frames, as they are called in England, have not gained a place in American practice is not easy to explain; the probability is that, if in large cities, some

timber-yard owner would provide a set of such machines and cut out to order for his customers such sizes as are wanted, the business would be profitable. It would, for one thing, save much expense and waste in planing, as planing would be unnecessary except for surfaces to be painted or varnished.

Prominent among wood-working machines, and the first to relieve workmen of heavy drudgery, are saw benches,—machines con-

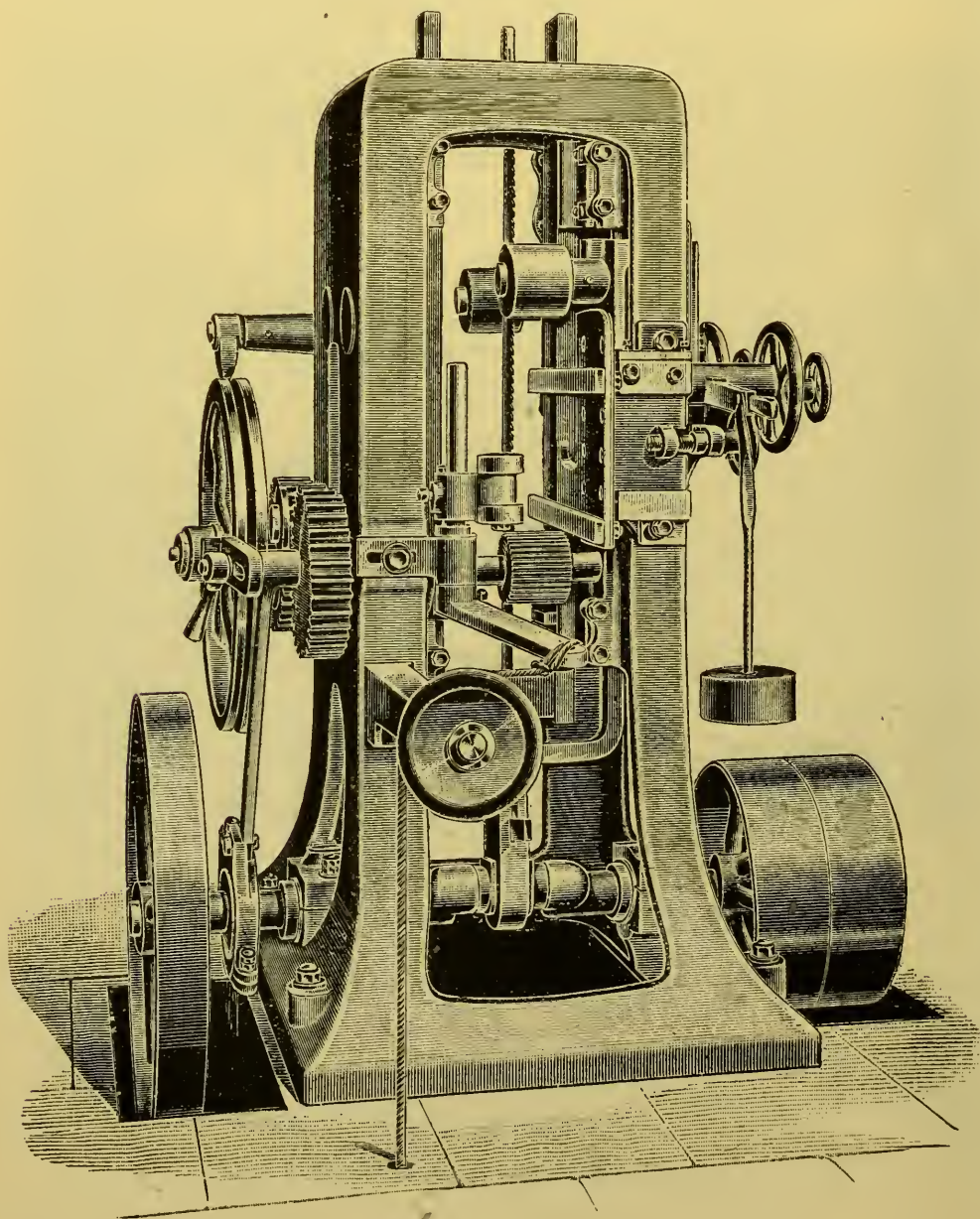


FIG. 13. SINGLE-FRAME RESAWING MACHINE.

Arranged with roller feed for resawing deals to dimension sizes. A typical English machine.

sisting essentially of a bench with a circular saw projecting through the top and adaptable to a wide range of purposes.

In these machines, as in most other classes, there is wide divergence between American and European practice, and in the uses to which the machines are applied. Practice or design arises out of uses or adaptation, and this accounts for many differences between the machines, as will be explained further on.

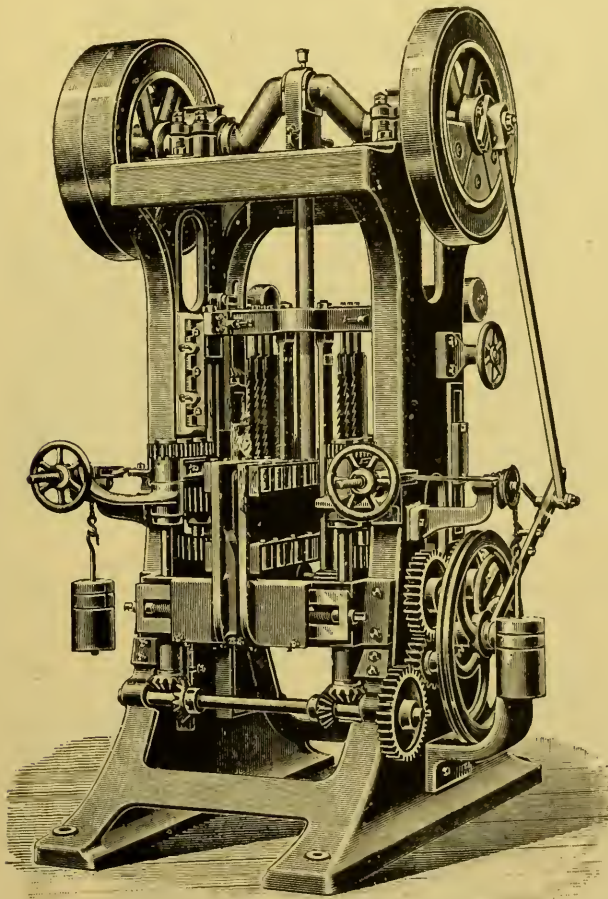


FIG. 14. DOUBLE-FRAME RESAWING MACHINE.

Arranged with vertical and horizontal feed rolls, and adapted to receive two deals, one at each side, with a gang of saws for each.

Saw benches in the United States are commonly made for light work, such as cross cutting and ripping boards and planks; but in Europe they are employed for heavier work, and are provided with saws four, and sometimes five, feet in diameter. American saw benches are nearly all for hand-feeding, and in Europe nearly all have some kind of gearing to feed or advance the timber — an indispensable feature for large and heavy pieces, such as round logs up to 18 inches' diameter, which are sawn there on benches.

This term saw bench is a flexible one in its application in Europe, and, as the illustration will show, is applied to machines

that in America, would be called "saw mills;" in fact, the term bench is applied to almost any kind of a machine for operating circular saws. Saw benches are made in a heavy substantial manner, the spindles being large and fitted in gun-metal bearings, and the frames being cast in one piece.

There are some features in European saw benches that could

with advantage be adopted by American makers, and will have to be, if saw benches ever become an article of export trade. One of these is the method of arranging the fences, or gauges, that guide the timber. In respect to these, it may be noticed that in all of the European machines these gauges do not extend much beyond the teeth at the front edge of the saw, and it is not easy to find any reason for making them longer. Evidently the timber should be free laterally after it is sawn, or behind the cutting teeth, because no guidance or direction of its course beyond that point is possible or re-

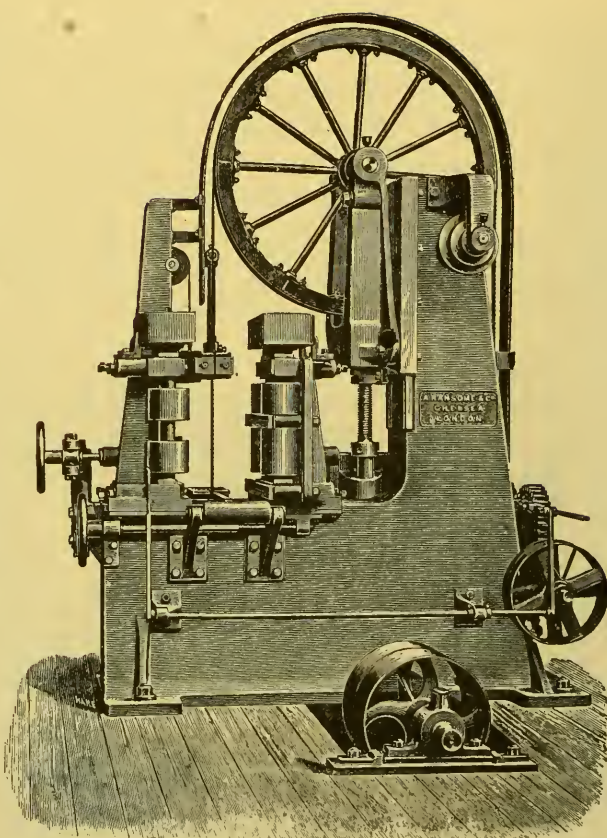


FIG. 15. BAND RESAWING MACHINE.

A substantial machine of moderate size, representing English practice. Band resaws are not so much used in Europe as in America, the deal machines being preferred.

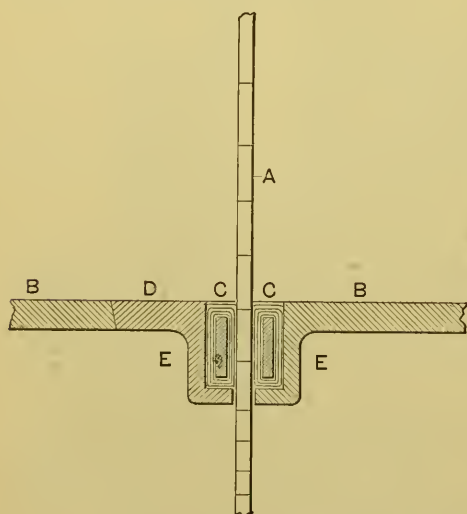


FIG. 16. PACKING BOXES FOR CIRCULAR SAWS.

The fibrous packing is fitted into cavities in the table, and serves to retain a lubricant as well as to steady the plate.

quired, and a gauge extending back past the saw, if straight, must be set obliquely to the saw, to prevent crowding the teeth at the rear.

In Europe the saw gauges are made with a loose, or adjustable, face, which can be set parallel to the saw, both horizontally and vertically, and moved forward or back to suit large or small saws, so that the gauge will not extend beyond the teeth at the front and that a piece, as soon as sawn through, will be free at both sides of the saw and can be removed

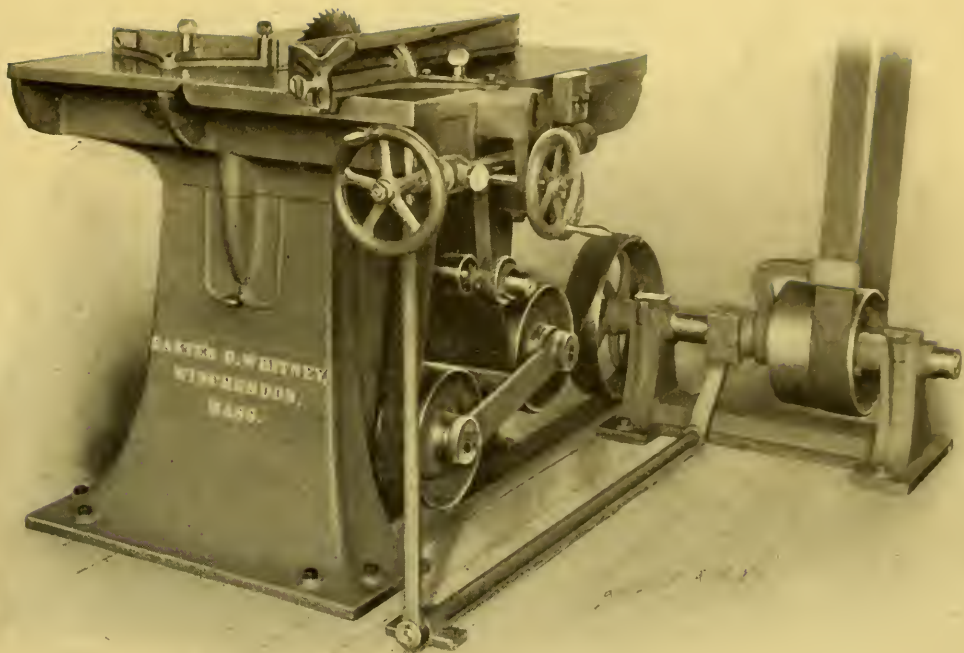


FIG. 17. DIMENSION SAWING MACHINE.

With ripping and cross-cut saws, adjustable to any position above or below the table, and with guides and gauges for the most accurate kind of dimension sawing.

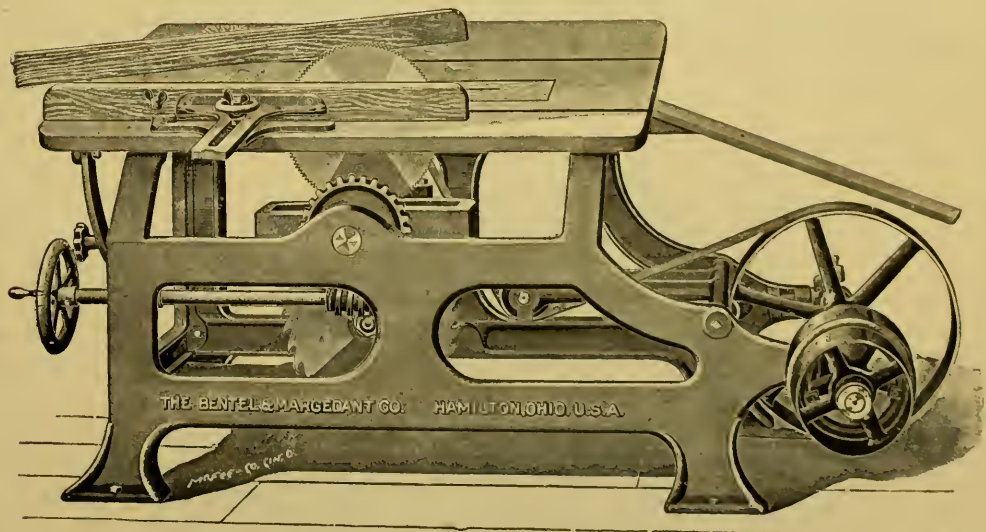


FIG. 18. COMPOUND SAW BENCH.

The ripping and cross-cut saws are mounted on a frame, so that either one can be projected through the table to various depths, and adapted for a variety of work.

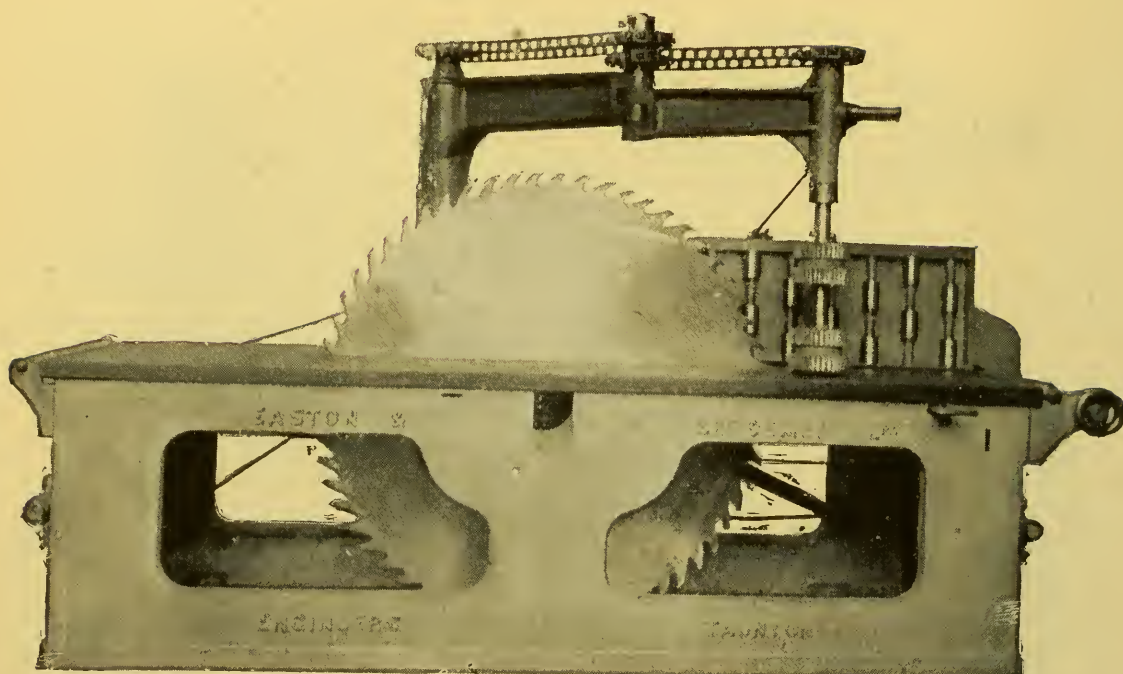


FIG. 19. CIRCULAR-SAW BENCH WITH IMPROVED SELF-ACTING CONTINUOUS FEED.

without the dangerous operation of pulling it out from between the gauge and the saw.

Another feature is what are called packing boxes at each side of the saw, in front of the saw collars, as seen in Fig. 16. It is because of this device that circular saws are made much thinner in Europe than in America, and are driven with less power. Saws 36 inches in diameter are sometimes made as thin as No. 14 by the wire gauge, and are rarely thicker than No. 12. The packing boxes

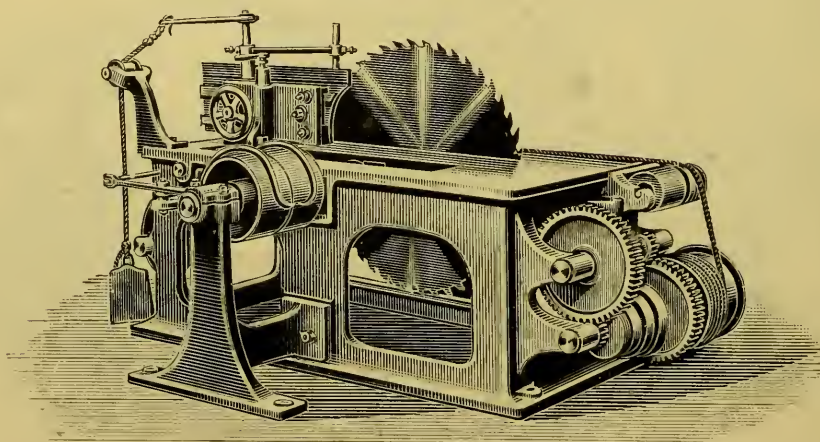


FIG. 20. SELF-ACTING SAW BENCH.

Constructed with rope feed, and representing a class of machines in extensive use and of remarkable performance.

have two functions: they support and steady the saws, and keep them lubricated. If a saw is crowded laterally, or is pinched by the timber, it instantly heats, and this melts or thins the oil in the packing just when it is needed.

Considerable space is taken up by illustrations of European saw benches, and a good many readers will be at a loss to know why these machines have such prominence, and are so heavily constructed. An explanation of this may contain useful suggestion. In America most establishments using timber in their manufactures purchase the material sawn into boards, planks, and scantlings. In Europe timber is commonly purchased in the log, by the cubic foot,

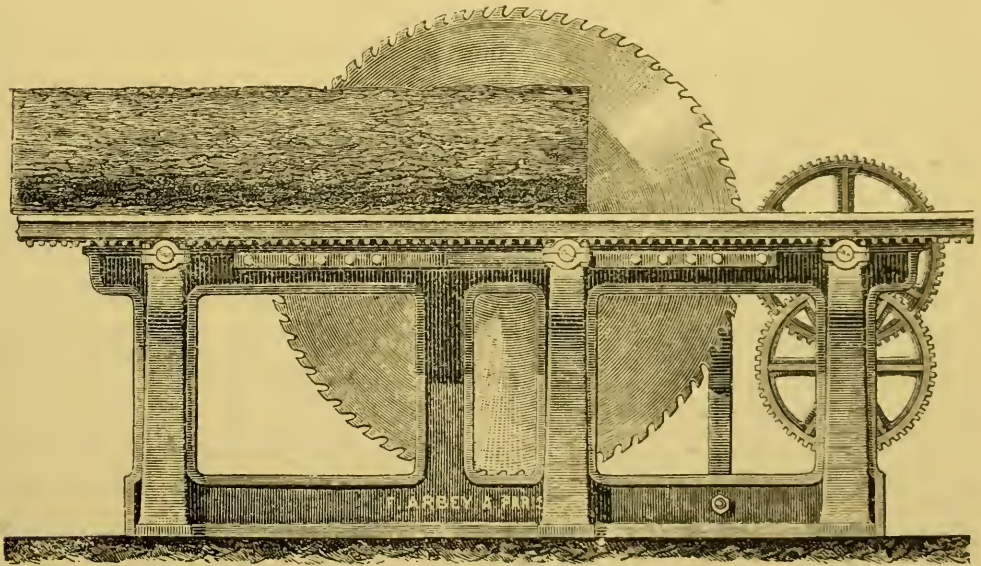


FIG. 21. HEAVY SAW BENCH WITH RACK FEED.

The table is in two parts, one on each side of the saw, both being moved simultaneously by shaft, pinions, and racks.

and is sawn as wanted to the particular sizes needed; hence the necessity of these powerful saw benches.

The writer has reason to believe that the European plan is best, and might be adopted in the United States, with many advantages, and in this belief he brings to his aid an experience as mechanical manager of a large company at Columbus, Ohio, that consumed yearly about 60,000 to 100,000 cubic feet of hard-wood timber of various kinds. Experiments were made in purchasing a portion of this timber after it had been sawn at the mills, with the result that the cost was nearly doubled and the quality obtained was decidedly inferior. In the end all the stock consumed was cut from logs of oak, beech, hickory, maple, and ash woods, and, strange to say, experience and "natural se-

lection" led to the use of specially-designed saw benches, closely corresponding to those in the last five figures of the illustrations, but less complete and efficient.

The logs were received in short lengths, split when too large, and were sawn with the grain, and also with respect to the growth,—a method which produced better material; they also could be selected, and apportioned to suitable purposes. Two men could easily saw into small sizes five cords, equal to 6,000 feet, board measure, in a day, cut accurately to the dimensions wanted. The waste furnished fuel for the works and left a surplus that could be sold for \$300 to \$500 a year.

It is possible, in almost any part of the United States, to purchase hard-wood timber by the cord, or cubic foot, at a low price compared with that of sawn material. It is evident that the hauling to saw mills, the sawing charges, and the hauling again to a place for shipping, must cost about half as much as the timber. It is also evident that quality must be inferior when the material is sawn into flitches without regard to growth or grain. In the case spoken of, and in others at the same place, where extensive manufactures in wood were carried on, it would have been preferable to purchase the timber in the log, if sawn stuff could have been obtained at the same price per cubic foot.

It is common to hear it said by consumers of hard-wood timber: "We do not want to trouble with a saw mill;" but, as the illustrations of European saw benches will show, a saw "bench" is all that is required, if it be properly made and strong enough for the work.

THE PROSPECTIVE EXPANSION IN AMERICAN SHIP-BUILDING.

By G. R. Dunell.

THE British ship-builder who keeps an intelligent eye on industrial progress abroad sees nothing much plainer just now than that he will be, probably before very long, face to face with serious competition from the United States. The prospect is not a pleasant one, and therefore he will avoid facing it as long as possible. But it is inevitable in the nature of things, for there are natural laws which govern economics just as there are natural laws of another kind which direct physical phenomena. The great rivers flow in dependence on these natural laws. Man may meddle a little here and there,—erecting a dam or straightening a channel, imposing a tax or granting a bounty,—but the rivers keep to their valleys, and the streams of commerce roll just where the natural conditions are most favourable, in spite of petty obstructions such as legislative enactment or protective tariff and fostering bounties.

For ship-building and marine engineering (which is a part of ship-building largely considered) natural conditions are becoming exceedingly favourable in the United States. We find there, first of all, a race ingenious, resolute, ambitious; a people who have been, by the working of nature's two great laws, survival and heredity, fitted to grapple with large problems and win success in the face of difficulty. That is the first requisite, without which the rest is of no avail. Nature has also given this nation a long coast line, harbours, and those mineral riches which are now the raw material of the ship-builder. These conditions being present, the Americans, in becoming ship-builders, are but working out their natural destiny.

The Americans have once already shown themselves well fitted for maintaining a ship-producing industry. This was in the days when mechanical propulsion was in its infancy,—when steam engines were not a very serious factor in the ocean freight trade of the world. But who doubts the mechanical genius of the Americans? by their boldness and originality in engineering conceptions so much the more are they now fitted for the work of sea-carriage in these days of universal steam propulsion. When America formerly held a high position as a ship-building country, she had raw material in abundance, her forests af-

fording a plentiful supply of timber. Her well-designed ships then furnished models which the British were fain to copy; and the fearless manner in which the ship-owning firms managed their business subjected British enterprise to a test such as it had not before been put to, and has never experienced since. Artificial restraints—those dams to which I have already made reference—did something to destroy, or perhaps, rather, check, the career of the ship-building industry in America, but natural causes have contributed immeasurably more to this end. When iron, and later mild steel, became the materials for ship construction, it was not in the nature of things that America should produce them, for the natural laws of the industrial development are not to be unduly hurried, any more than those governing physical phenomena, and the country was not then ripe for iron-making on a big scale. The energies of the people, great as they were, had been engaged in other directions. The vast mineral riches of the continent were unknown, or, if known, were not in a position to be utilized. No one can doubt, however, in spite of the depredations of the Alabama, that, had the United States possessed an iron-making industry equal to that of England after the close of the civil war, the national qualities which enabled the country to compete so successfully in the days of wind-driven wooden hulls would have kept her flag floating beside the red ensign in the ports of the world.

These things are worth considering by the British ship-builder and the British ship-owner just now, for, if they look across the Atlantic, they find that this great bar to the establishment of a modern American ship-building industry, the lack of raw material, has recently been removed. In 1890 the president of the Iron and Steel Institute, Sir James Kitson, addressing an American congress, said: "The supremacy of our (British) ship-builders and our shipping interest is based upon the excellent quality and the abundant supply at moderate prices of steel furnished by our steel makers." Now the United States produce more pig iron—the primary raw material of steel, and therefore of ships—than any other country in the world, not excluding the United Kingdom. This matter lies at the root of our subject.

Pig iron, as has been said, is the chief raw material of the ship-builder; that and timber, of which there is plenty in America, a little copper, of which there are also excellent native supplies, paint, varnish, and some other accessories, are all that are needed for ship construction and marine engine building. Iron, however, is the dominant factor, the term, of course, including that description of iron known as mild steel, but more properly called ingot-iron. Going

back thirty years, we find that the production of pig iron in the United States was 1,431,250 tons in 1868, while during the same year Great Britain produced 4,970,206 tons. In 1897 the total production of pig iron in the United States had increased to 9,652,680 tons, while for the same year in the United Kingdom the total was 8,789,455 tons. Thus we see that, while Great Britain was roughly 3,500,000 tons ahead of America thirty years ago, twenty-nine years later she was not very far from a million tons behind. It was in 1890, the year of Sir James Kitson's address, that America first forged ahead, and, except in 1894, she has kept the lead ever since.

It is not all pig iron, however, that is suitable for ship-building purposes. But this remark would have possessed greater weight ten or twelve years ago, and is likely to possess less in the future than it has at present. This is to say, the spread of the basic process of steel making appears likely to bring us nearer, so far as the utilisation of native products is concerned, to the conditions which were present when iron, and not steel, was used for ship-building; for we can now use in basic-lined furnaces those phosphoric or non-bessemer ores which are not admissible with the acid process. When ships were made of wrought iron, as they were for many years after the first year we have dealt with, any country producing a fair iron ore was able to convert it into good ship-plates, angles, etc. In those days England claimed that her engineering and ship-building trade held an almost impregnable position, because iron-stone, coal, and limestone were in close juxtaposition, and that, too, near the sea. Though other countries possessed these minerals, they were more or less widely distributed, generally inland. Freight had to be paid on one or more of them, thus bringing up the cost of production. In those days, too, the notion that there was something native to the "right little, tight little island" which would always enable Britons to defy the world in such matters had not received the unpleasant jars which it has since experienced.

However this may be, the facts as to geographical distribution, or, rather, concentration, of materials were true, and the arguments founded on them were sound at the time. Since then what a change we have seen! The very practice in engineering which Englishmen initiated has wrought such wonders in annihilating distance that coal, iron ore, and limestone, though long distances apart and hundreds of miles from the sea-board geographically, commercially may be close together and within easy reach of a port of shipment. On the American continent this has been due chiefly to the wonderful development

of the railway,—a matter we shall refer to again later,—while on the ocean the work has been almost wholly British.

Another step, besides easy freight, was needed to shake the comfortable British supremacy founded on iron, coal, and limestone in narrow compass; and this step was brought about also by an Englishman, who thereby put the ironstone of his native country out of the market so far as shipbuilding was concerned. When Henry Bessemer was struggling to introduce his great invention, with courage as true and a will as firm as his own steel—fighting the world of science and industry to establish his process,—he was an unconscious servant of destiny, initiating a change destined to alter the whole aspect of a great industry, and to cause a shifting of the basis of iron making that now, after many years, gives an opportunity to the rivals of his native country. British ores, for the most part comparatively rich in phosphorus, were nevertheless suitable for the production of wrought iron, but were quite unfitted for the manufacture of mild steel by the acid process,—the only process known until long after. Great Britain had only a few deposits of non-phosphoric or bessemer ores, and thus it came about that, so far from getting ore, coal, and limestone from one district (it is said that occasionally all three have come out of the same pit), she has, during many years past, been sending hundreds of miles across the ocean for very nearly all the iron ore that is smelted and worked up for ship construction.

If we turn again to statistics of the British iron trade for the year 1897, we find that, of the 8,789,455 tons of pig iron produced in Great Britain, 2,601,806 tons were devoted to the production of open-hearth steel ingots. In the United States, during the same period, the production of open-hearth ingots amounted to 1,631,843 tons. Now it is hardly necessary to say that open-hearth steel is that description from which ships are built. It must not be confounded with bessemer steel, which is the product of the converter, but it was Bessemer's invention which led to the introduction of the open-hearth process, which we owe chiefly to a Frenchman, Martin, who adapted Siemens's furnace to steel-making purposes. Though the American output of the open-hearth steel falls considerably short of the British, it is amply sufficient to prove that the production can be increased when the demand arises; indeed, it is increasing, year by year, in a very substantial manner. If confirmation of the ability of America to supply raw material for ship-building be needed, witness the fact that American steel makers have been rolling ship plates for the British market.

There are, it is true, special reasons for the import of such mate-

rial into England, or, rather, Ireland, just now,—reasons which may prove of a transitory nature. This, however, it is fair to say, is not the opinion of some Americans connected with the steel trade, who are sanguine that they will secure a substantial share of the business in England; and certainly the experiment is not being looked on with indifference by British steel makers. The bringing of steel plates, angles, etc., across the Atlantic appears, however, too much like directing the stream of commerce into artificial channels ever to gain permanence. In any case, if Great Britain should have to rely to any extent on a foreign source of supply, there would be a poor prospect for her in the building of ships. Such an eventuality, is not, however, what we have now to consider; the question being rather whether America can supply herself with manufactured steel for ship-building on terms equal to those existing in Great Britain.

Turning again to our table of statistics, we find the production of open-hearth steel divided into two classes, acid and basic. As is well known, the basic process was an English invention, but has found more favour in foreign countries, notably Germany, than in the land of its birth. Of the 2,601,806 tons of open-hearth ingots produced in Great Britain during 1897, not less than 2,393,718 tons were made with the acid process from non-phosphoric ores, mostly imported, thus leaving only 208,808 tons to the basic process. In the United States, on the other hand, during the same year, out of the total of 1,631,843 tons of open-hearth ingots, 1,075,689 tons were of basic steel, and only 556,156 tons were of acid steel. It may be added that during 1897 Germany produced 1,304,423 tons (metric) of basic open-hearth steel. This was made largely from native ores very similar to the large British deposits, though a good deal of highly phosphoric ore, rich in iron, is imported.

In the early part of this year an English engineer well acquainted with American metallurgical practice, Mr. Archibald P. Head, of 47 Victoria street, Westminster, read an extremely interesting paper on "The American Iron and Steel Industry." In this valuable contribution the author not only showed to what a remarkable extent the Americans were forging ahead in the iron-making industry, but also gave details of the way in which they gained their end. Many of the advantages they possess are the result of physical conditions, but not a few are due to natural characteristics—enterprise and that rare intelligence which makes scientific discovery minister to commercial success through the channel of wise and liberal expenditure.

The net result of all these conditions is that not only pig iron,

but manufactured iron and steel, can be produced more cheaply in the United States than in Great Britain, and that to an extent of which few not connected with the industry have any idea. Thus, to quote Mr. Head's figures, bessemer ore could be sold in Pittsburg at 11s. 6d. per ton, while the price in Middlesborough was 14s. 9d. This, however, is not all, for the American ore has 63 per cent. of iron in it, while the Spanish ore used at Middlesborough has, say, 50 per cent. Here there is an advantage for the American steel maker at the start, for he has his ore brought to the coal and limestone at 3s. 3d. per ton less than the price at which the Englishman gets his. In both cases long distances have to be traversed, and the American has the great disadvantage of land carriage. But the American railway engineer has made so good use of his opportunities that the railway rate for minerals is less than half that in Great Britain, and often very greatly below that figure. Of course Bilbao ore has practically no railway carriage in transport to Middlesborough, while the ore for the Pittsburg furnaces is taken some distance by train. If the American freight trains were run upon the English goods system, the 11s. 6d. paid for iron ore in Pittsburg would be considerably increased.

Continuing with Mr. Head's figures, we find American coke 6s. 6d. per ton as against 13s. 6d. for Durham coke, and, although the United States fuel has not the appearance which a Durham maker considers indispensable, it gives good results, being hard and bearing the burden in the blast furnace very well. Coal is notoriously cheap in Pittsburg. Mr. Head gives steam coal at 3s. per ton, which is much below the prices that rule in England. As a result of these and other conditions, bessemer pig is produced in America at 40s. per ton as against 50s. per ton* for the Middlesborough pig. Non-bessemer pig is given as 38s. 9d. for Pittsburg and 40s. 9d. for Middlesborough. Having read these figures, we are not surprised to find the price of steel ship plates to be £4 12s. at Pittsburg as against £5 10s. at Middlesborough, though, in considering these quotations, it must not be forgotten that ships can be built at Middlesborough, while the Pittsburg plates would have a long journey to make to the ocean ports. For boiler plates the prices given are £5 10s. 6d. in America and £6 10s. in England.

There are two matters to both of which the sturdy and optimistic British ship-builder is apt to refer when one speaks of the danger of American competition. These are dear labour and protection, the

*These figures are averages, taken from Mr. Head's paper. They naturally alter from time to time.

former being looked on as the result of the latter. But protection in America, as we have seen, has not had the result of raising the price of raw material for ship-building above that which rules in England—a free-trade country. As we are not discussing political economy, we may let that matter rest for the present. It may, however, be useful to point out that the United States, as a vast industrial continent,—a world almost in themselves,—are essentially free-trade. If ore from Minnesota or Wisconsin had to pay duty on going into Illinois or Pennsylvania, and if New York or Massachusetts imposed a heavy duty on Illinois and Pennsylvania plates, beams, and angles, the chances of American ship-building would fall to a low ebb. But if, for a minute only, we consider each State of the Union as a separate country, we find that there is no parallel in the world to the extent to which free trade prevails on the American continent; and there is certainly no other equal area of the globe, comprising so vast and varied natural resources worked industrially, that is without the bar of customs and tariffs.

The two great items of cost to a ship-builder are labour and materials. The latter we have dealt with so far as the limits of our space and the nature of this article permit; upon the former we must say a few words. Undoubtedly wages are higher in the United States than in Great Britain; and this is true of both “tradesmen” and unskilled labourers. Mr. Head gives 19s. a week as the wages of the latter in England, as against 25s. a week in America, and this may be taken as a fair basis of comparison, both for the artisan and the labourers of the two countries respectively, the difference being roughly 25 per cent. to 30 per cent. Now, it is difficult—in fact, impossible—to put on paper concrete facts and figures in support of what I am about to state, but I am confident that few—I had almost said “no one”—who have had experience of both the European and the American mechanic will doubt that the American employer gets more than value for the extra money he pays. The British ship-builder who disbelieves in American competition—almost necessarily an untraveled British ship-builder—does not take this view. “There is,” he says, “necessarily so much unskilled labour in ship-building, labour where brawn counts so far above brain, that wages must always tell in the end. Moreover, ships and marine engines are not like bicycles, where automatic machine tools can cut them out of a few lengths of tube and a few rolls of wire.” No doubt the genius of the American engineer for labour-saving is most apparent in the “repetition work” involved in the production of bicycles, sewing machines,

type-writers, etc.; but a ship-builder need be by no means elderly to be able to look back on a good deal that has already been done to substitute mechanical appliances for hand labour in his own trade.

Nevertheless the average ship yard is a rude affair. It is true that plates are not holed with a hand-punch, or divided up with a cross-cut chisel, but the punching and shearing press, with a few uncared-for drilling machines, appear to be the highest flights of mechanical science to which a good many ship-yard managers are capable of soaring. This state of affairs is largely the result of what has been almost a monopoly in ship-building possessed by Great Britain. Absence of competition has told its invariable tale. This result has also largely been due to the "rushes" and "booms" to which the ship-building industry has so long been subject. Yards are overcrowded with work for a time, and then all but empty for an equal period. Either there is no time to introduce improvements, or no money is being earned to make them worth while.

I would add a few words to prevent misconception. From a naval-architectural point of view the science and practice of ship-building has been brought to a high state of perfection in Great Britain, chiefly owing to the influence of the Institution of Naval Architects, which numbers in its ranks a body of men unequalled as ship designers. The various questions of fluid resistance, stability, strength of structure, and other professional problems are studied and discussed with a scientific knowledge and practical grasp leaving little to be desired; but the average naval architect is no mechanical engineer, and what little attention he bestows on the subject is devoted to the marine engine. Hence it is that the ship-yard plant had been too much relegated to persons of small authority and smaller pay. Those who know of the trouble the late Ralph Tweddell had in trying to introduce hydraulic appliances for ship-yard use will appreciate this part of our subject. No thoughtful engineer can go through an ordinary ship yard and see the gangs of men carrying, lifting, pulling, and hauling, without feeling sure that much might be done in the way of improvement. It is in this direction that the American attack is likely to be most successful, and that what has already been done to some extent in American steel works will be extended in the slips and shops of the ship yard; in fact, a beginning has already been made. Certainly cheap labour will not save the situation for Great Britain, once mechanical ingenuity is brought to bear. The American ship-builder will have the advantage of a more sensible and teachable class of work-people, who are tolerant of new appliances and do not blindly

oppose changes because they seem at first glance to be against the interest of labour. It is but fair to the British ship-builder to say that many suggested improvements and advances have been rendered impossible by labour difficulties, which seem now near an end.

The returns of the United States navigation bureau show that "during the first quarter of the current fiscal year (1898) the capacity of the vessels built and officially numbered was 83,191 tons." This should be compared with 26,805 tons for the corresponding period of last year. These figures are small compared to the enormous British tonnage returns, but they are not insignificant. On the contrary, they are extremely significant if we examine them more closely, for a large percentage of the new tonnage is designed for over-sea traffic, whereas formerly the whole of the American-built ships were intended for the domestic trade. Of late there has been a substantial decline in the construction of steamers for the big lakes. We are told, moreover, that there will be a considerably larger aggregate output of tonnage for ocean trade in the immediate future. A New York paper states that in eight ship-building yards of the United States there are being built (October, 1898) ships which will add to the American merchant-marine one hundred thousand tons. In these yards thirty-six steamers are being built, six for foreign account.

Of course, the figures above given are subject to heavy discount. A good deal of American-built tonnage is still of wood, and a large part of the coasting trade is carried on by sailing vessels. Still, very fine steel steamers are built for the big lakes,—vessels which, either as passenger or cargo carriers, are designed with an intelligence and appreciation of what is needed that is beyond praise; indeed, in freight-carrying appliances the American steamers are, in some respects, as far ahead of European vessels as are the goods-traffic features of the American railways superior to those of the old world.

The ruling-factor, of course, is price, and at present anyone wanting a steamship can buy it cheaper in England or Scotland than in America. How long is that likely to continue? Material, as has been shown, has already been made more cheaply in the United States; labour, on the other hand, is dearer. But the American has a way of doing things and producing things with dear labour more cheaply than others can with cheap labour. That is because he substitutes machinery for muscle, and employs his dear labour where thinking is needed. "Labour is dear, capital is cheap" is his maxim; and so he thinks nothing of borrowing a few thousand dollars—and that at very much higher rates of interest than are paid in England—to spend

upon machinery, if the interest on the borrowed money comes to less than the sum he saves in wages. That is a course open to all, but British manufacturers do not generally look at the matter in this way.

Great Britain is still supreme as a ship-building nation, and, if the ship-builders and steel makers of the country choose to provide in time, there is no reason why she should not continue to hold the first place, with America perhaps a good second. She has a splendid geographical position, placed between the two civilised continents. She has reputation and connection—what auctioneers call “goodwill.” She has, moreover, the men,—a population of mechanics and other artificers who have been trained to their trade. I have spoken of the advent of labour-saving methods in the American ship yards. It would, of course, be easy to make too much of this, for the trained man will always be needed, and, the more highly-specialised tools become, the higher must be the training and capacity of those who direct their use, not necessarily those who directly use them. It would be well if British ship-builders could take the initiative by raising the wages of their best men (before the latter go out of the country) and compensate themselves by reducing the demand for labour through improved mechanical devices.

To sum up an article not intended exclusively for ship-builders and experts, Great Britain has lost the advantage she long held in the lesser cost of steel, but she still retains “goodwill” and trained labour, both of the shops, the yard, and the drawing office. America has iron-ore resources which the older country does not possess,—much of her open-hearth basic steel is made from ores almost of bessemer quality,—but, if England makes intelligent use of the good things nature has put within her reach, much can be done to neutralize the advantages possessed by her rivals, in regard to raw material, and bring her nearer to an equality. She will never get back her sometime supremacy—to that great past of “Britain first, the rest nowhere.” Other nations are catching up fast, and it is about time she woke up to the fact that, unless she struggles hard for her own, she will drop even to an inferior place among the manufacturing countries of the world.

Since this article was prepared, prices of steel plates, etc., have risen largely, both in Great Britain and the United States. The conclusions, however, still hold good, for what has occurred may occur again. Whether the present “boom” in the iron and steel trade will delay or expedite American shipbuilding development, remains to be seen.

AMERICA AND GERMANY AS EXPORT COMPETITORS AND CUSTOMERS.

By Louis J. Mudge.

III. SUGGESTIONS FROM GERMAN COMMERCIAL AND INDUSTRIAL METHODS.

GERMANY'S, and especially Prussia's, greatness is usually attributed to the mighty military organization under which each man is a machine and all spontaneity and individuality are crushed out. This reason, however, cannot account for a vast commerce and industry, nor could the industry have attained to such dimensions if militarism and bureaucracy were as important elements in the character of the nation as they are frequently said to be. The Germans were merchants before they were soldiers, and, despite their splendid army to-day, one does not get the impression in their offices or their factories that they are bereft of liberty, down-trodden by imperialism, or turned into machines by the army. The army, on the contrary, is considered by those best informed to have a beneficial effect—physically, morally, and intellectually. The officers are frequently very hard workers, and those of them who leave the army after years of service to enter the industries bring with them, not only system and discipline, but often a fine capacity for hard work, and not a little technical knowledge. The young engineer who, by reason of his education, has to serve only one year in the army, always profits by the experience, and his career is not disturbed by it.

The personal contact which German and English firms maintain with their customers abroad has been recognised as a great element of their success. The exporting firm should follow up in detail and with deep interest the efforts of its travelling members. The manager at home should know fully what his agent has to compete with, and then try to adapt himself to the conditions. He should keep his agent supplied with ammunition. The agent's complaints should be studied almost prayerfully.

The Germans ought to be the most experienced exporters in the world. They began their foreign trade with the great trade guild which the North German cities founded some six hundred and fifty years ago for mutual protection against not only the pirates and wreckers of the North sea, but also the robber barons of their own land. Long before that, even, the "People of the Emperor" were ac-

corded in English ports equal rights with the English, and the commerce of England was in their hands. It is probable that the coin which they struck in England, the money of the "Easterlings," gave its name to the pound sterling. The staid old firms of the remaining Hansa free cities—Hamburg, Bremen, and Lubeck—have kept up trade traditions from a time when, at the very dawn of international commerce in Europe, the merchant accompanied his own wares by sea and land. Now they gather for redistribution, in their magnificent free-port warehouses, the products of all the world. A younger member of the firm spends a few years in Para, or Valparaiso, or Shanghai. He learns the language, the people, and the difficulties. He returns and settles down to Hamburg home life again, but he continues to "feel with" the colonial part of the firm. The result is that his house does not write exasperating letters, pack badly, or make terms of payment foreign to all the ideas of the customers. The rest of Germany, however, cannot be compared with the Hansa cities in knowledge of export methods. The Hansa people are English in the matter of feeling and filling the wants of a distant clientele. The little town of Remscheid (which town, by the way, had the third trolley road in Europe) and the town of Solingen are surprisingly international. It seems strange to find that their manufacturers have been to Mexico, Australia, or Africa to sell their tool steel, skates, files, and cutlery. One hears with equal surprise the Spanish language on the lips of yellow-bearded Teutons in Barmen-Elberfeld.

If an impartial observer were to study the export trade of the world as it is now developing, and then frame only two maxims, I think he would say: first, manufacture well and cheaply; second, learn foreign languages. None of us can tell when we are going to need to use a foreign language. It is like a revolver; when you want it, you want it badly. I do not mean exactly that we should all learn Dutch, or Finnish, or Russian; but, when the Russian addresses you in good French or German, it is simply disheartening to have to gesticulate, and blush and curse your years of Greek and Latin and your early training, and ask him if he speaks English, and explain that you never happened to learn French or German; that you had read a good deal, but forgotten it, etc. Why, even if you don't go into the export trade, you may be ambassador some day. Our languages we learn like the maps at school; we can name all the rivers, capitals, and capes, and "bound" everything; then, when we sail up the Elbe, we haven't the faintest idea as to whether it rises in the

Alps or the Apennines. The actual speaking and writing of French, German, and Spanish should become an acceptedly natural part of our popular education. Instead of being the speciality of fortunate sons and daughters whose parents live a part of the time in Europe or have the means to employ foreign-born governesses, these languages should be put within the reach of every mechanic's son from the time he enters our splendid public schools. The Germans teach their youngest gymnasial students, if they are taking the classics, to speak Latin. An American friend, who had spent some seven years on Latin at home and then taught it for five years, continuing his studies at Jena, was disheartened to find 12-year-old boys saying Latin sentences which he could scarcely follow. If German teachers can accomplish such things in a dead tongue, Americans ought to be able to do it with a live one. I know many Germans who have never been out of their own country, but who have obtained a good speaking knowledge of French and English in the common schools. A continent lies to the south of the great western republic with whose future the people of the United States may be closely connected. Spanish is exceedingly easy to learn. Why should not all learn it? And even if one never travels, how much that is valuable in foreign literature would be opened to one who reads other languages with ease.

In the every-day work of the large German offices and factories the American notices many departures from his own methods. In general, the strict order and organization evident everywhere in German life characterize the conduct of large concerns. A great many offices work with an intensity equal to that for which Americans, as a nation, are so famous; but results are not so soon evident as they are in the United States, because the public demands voluminous information—including drawings, descriptions, guarantees, weights, and dimensions—before definitely placing an order. Engineering works are usually planned in the central office, so that a minimum of detail is left to the individual judgment of the engineer locally in charge. The commercial side is carefully looked after. The carrying out of engineering enterprises is, as a rule, preceded by an estimate of earning capacity based on running costs, depreciation, interest, amortization, and a conservative rating of income. The engineering firms have not infrequently to take very heavy guarantees for running costs. It is customary to have, for registering, beside the ordinary copy-books, portfolios into which are fastened, in order of time, all incoming or out-going (in copy) communications regarding any enter-

prise, so that one leaves a complete history of the case for one's successor. A great deal is put into writing which we perhaps settle verbally,—a characteristic which has its advantages as well as its disadvantages. Bureaucratic methods have so long flourished that they are justly feared, and are not allowed to have too much sway, in the modern German office. All letters are signed by the management or its legally-appointed representatives. Labor-saving office devices are eagerly sought, and the typewriter is thoroughly introduced. It is somewhat remarkable that the Germans, with their great love of system, should have made hardly any use whatever of card catalogues and the decimal system of classification. There are very few office buildings in Germany designed as such; there are no high buildings and very few elevators.

Although there is an ever-growing tendency in all countries to patronize home industries, the complexity of our modern requirements seems to work in the direction of a general interchange of products. The demand for specialties of a high quality will, in the end, overrun political boundaries. The question as to where an article has reached its highest development and lowest price plays a part of more practical importance with the purchaser than his theoretical desire to help home industries. The French and Austrian governments put conditions of home manufacture in most franchises, thus seriously interfering with importation. The Germans are intensely patriotic, but they know how to appreciate a good thing when it is offered to them, no matter where it comes from. They may purchase, for instance, the best machine in the world from America, so that they may manufacture with it some other type of machine which shall be the best in the world and be eventually exported to America.

My observations do not confirm a somewhat prevalent idea that the Germans are more given, in proportion to the greatness of their industry, to copying designs of machinery than are other nations. When they do build upon the experience of a foreign firm, they usually pay, directly or indirectly, and desire to make a fair bargain for what they can learn from their neighbor. The manufacturing of any American speciality in Europe does not necessarily put an end to its export by the home factory. Friendly relations with the foreign factories have frequently promoted the output of some of the home factories, due to the extensive introduction of the article which the European firm was able to secure by its influence and acquaintance with the market. But, if they do copy, have not others a debt to them for the results of their patient research in so many scientific

departments,—results which they have liberally placed at public disposal in their laboratories, clinics, and lecture-rooms? Have they not done a great deal of the tedious fundamental work on which we were quick to build? The line of evolution of any of our modern machines, from its inception up to date, would, if followed, lead through other countries than that of the inventor whose name it bears. Inventiveness seems to be more a generally-distributed national characteristic of the American, but a few individual Germans have had enough of it to make up for the rest of their countrymen, and then along with it all, is their colossal patience.

German engineers have usually a thorough theoretical training, including at least a year in some workshop as volunteers. Besides their training in the institutes of technology, engineers entering the government service have to pass severe examinations, work practically under experienced government engineers, and work out some special project, before they receive the title of "Baumeister." In the government service they are engaged chiefly as mechanical engineers, railway engineers, or building constructors. Naturally the ranks of the industry are largely recruited by government engineers who have left the chances of slow promotion, the slender salary, and the pension offered with the service.

The splendid achievements of German engineers in general are too well known to the world to need any praise, and an attempt at comparison with those of other lands would not be of value. A prominent technical educator told me that, to his regret, they were too often unpractical. The German youth, generally speaking, seem to be less inclined to play with tools and to "experiment" than our boys. They do not seem to have from the start such a love for machinery. It is perhaps not unfair to say that the German engineer suffers often from the quality of the lower "personnel" that he has to work with. The average German workman certainly has not as much ambition, energy, or quick perception as one would think from seeing the results of his work. He frequently rebels at the use of machines which displace manual labor, and seldom betters the instruments with which he has to work. He does not seem to get all the work out of a machine which it is capable of doing. These are weaknesses which may not, however, lie in the man himself as much as in his surroundings. German workmen who have spent a few years in America return to the fatherland with great energy and little patience with the slow ways of their fellow-workmen. German carpenters, cabinet-makers, plumbers, and mechanics in general have the

most clumsy and primitive tools—i. e., if they are working outside of factory organization. They do not lay out their work with regard to time, and rarely finish it at the time promised. Despite his heritage from the unsocialistic age of Veit Stoss, Peter Vischer, and Adam Krafft, the German artisan has to-day a poor eye for symmetry and a suprising lack of dexterity and cleverness. Of course modern factory methods are improving the workmen. Medium-size mechanical productions (not the so-called "small wares"), which require compactness of design, gracefulness of form, and refinement of external finish, combined with lightness and strength, seem to be a line in which Germans, for the present, have most improvement to make in the competition for the world's market. The typewriter, bicycle, and sewing machine exemplify this class; also, with some marked exceptions, household utensils, builder's and cabinet-maker's hardware, locks and screws, small tools, etc. These are clumsy, unpractical, roughly finished, and dear at that. Eminent exceptions, for instance, are the beautiful work in their army rifles, physical and chemical apparatus, measuring instruments, cutlery, etc., which show that the above-mentioned branches, in which they are not so strong, have simply been neglected. Of late many splendidly equipped factories have been built, and many of the older factories have purchased modern machine tools, so that a vast development of the industry, along lines which were faulty, is certainly in progress.

On the other hand, there are some departments which the Germans have pursued with such skill and energy as to give them an exceptionally high position,—for instance, in steam engines, boilers, electrical machinery, storage batteries, underground cables, chemical processes, and throughout their magnificent iron and steel industry. The electro-technical industry is especially well developed, as befits the country of its birth. One of the principal electro-technical firms in Berlin looks back upon fifty-two years of electrical manufacturing; another large electro-technical firm boasts of 12,000 employees in its factories, offices, and works abroad. This industry is supported, even in a more marked degree perhaps than any of the other industries, by the great financial groups. Most of the electric plant installed in Europe is made in Germany. Germany exports a great deal also to South and Central America and to the east. German firms are building practically all the large lighting and traction plants in South America to-day.

The gas motor is a noteworthy German specialty; it has been of the greatest service to Germany's "small" industry, one firm alone

having turned out in the last three years 3,196 gas motors for more than 23,000 h. p., and this output is about equalled by at least one other of the numerous factories. Generator gas plants are becoming common, especially for small electric light stations. As an instance of the economy of this system, I will cite the running costs of a small electric station near Hanover; the total coal consumption, including firing up and banking, in a week's test of 69 hours, with an average output of 48.7 h. p., averaged 1.83 pounds per effective h. p. hour. When one remembers that the largest and best steam plants return in work only about 12 per cent., and machines driven by illuminating gas as high as 26 per cent. of the available heat of coal, the revolution that further developments in this line can bring about seems worth working for.

The recent development of generator gas plants for larger powers* and the amenities of electric distribution have combined to make feasible the direct application of blast-furnace gases for power supply. Experiments have been made on a small scale in several works, but the Horder Verein, with a yearly production of 320,000 tons of iron, has taken the question up earnestly. It is now installing a combined gas and electric plant with four 600-h. p. gas motors. These will drive dynamos direct, and furnish power to the steel works and rolling mills three kilometers distant from the furnaces. The first motor was started in the summer of 1898, and indicated 620 h. p. with a gas containing 950 heat units per cubic meter. Even with all the gas available for this purpose, steam plants will have to be retained by the Horder works, especially for the large machines; but the displacement of smaller steam engines by a large number of electric motors would mean a very great economy, even for the 3,750 h.p. which it is proposed to produce eventually with blast-furnace gas.

These are only instances taken at random; anything like an analysis of the German industry is far beyond the intentions of these articles. Despite all that has been, or might be, written of Germany's modern bee-hive activity, immense practical achievement, and far-sighted preparation for the future, many American readers will doubtless still continue to think of the kaiser's realm as an "effete monarchy," with a gaudy throne, many beautiful castles, and a mediaeval sleepy people over-fond of beer. The newspapers, by neglect, ignorance, or distortion of the facts, have allowed the great clever western world to remain under such an impression.

* There are two German gas engines of 200 h.p. each, and one of 160 h.p., running successfully in Switzerland, and engines of 70 to 100 h. p. are frequently met with.

THE INTERNATIONAL ASSOCIATION FOR TESTING MATERIALS.

By Gus C. Henning.

AS early as 1872 a strong desire was felt among engineers in the United States to obtain more accurate knowledge of the properties of materials, because it had become apparent to many that the constants given in books of reference had been found unreliable, and, since new materials were coming into general use, also inadequate. This strong desire found its culmination in a petition to Congress and the Government which caused the appointment of the so-called "Commission to Test Iron and Steel and Other Metals,"* which, after having had the famous "Emery" machine at Watertown Arsenal constructed, and doing some valuable, but disconnected, work, was dissolved by Congress on June 30, 1879. The essential object of this commission was to determine engineering constants, but its members did not recognize the importance of accurate and reliable methods of doing this work. Had such been adopted, it would have been possible, with the amount of money spent, to have laid a foundation for further prosecution of the work by individuals.

In other quarters, however,—notably in Germany,—it had at that time been recognized by Bauschinger and others that it was of the first importance to develop methods which would always produce reliable and comparable results.

It is hardly necessary at this day to furnish proofs that tests of the resistance of materials can be compared only when made according to a uniform standard method.

Even the standard rules for furnishing and testing Portland cements, which were established by the association of German cement manufacturers as long ago as 1876, resulted from the perception that such agreement was necessary. So did the specifications for furnishing axles, tires, and rails of bessemer metal and steel, proposed in 1879 by the general convention of the Association of Railway Managers of Germany, which advised their adoption by the managers of the railways.† But these first steps to establish

* Trans. A. S. M. E., II, p. 86, et seq.

† The Properties of Iron and Steel," VIII. Supplementary volume of the publications of the Progress of Railway Construction, Wiesbaden, 1880.

standard methods of testing emanated from quarters which, from their nature, included only technical specialists, on the one hand,—purely manufacturers,—and, on the other, purely consumers; and although, in establishing these standards or norms, there was an endeavor to avoid prejudice, particular interests predominated, and this was urged against the standards on behalf of the opposite party.

Moreover, these deliberations related to one group of materials alone and were not confined entirely to methods of testing, also establishing requirements which these materials must fulfil when tested by the prescribed methods. For this reason it was certainly appropriate for professional men of the most varied technical callings to assemble at Munich, in 1894, at the call of the late Prof. J. Bauschinger, to attempt to formulate uniform methods of testing for the more important materials of construction.

The work of this Munich conference of 1884 coming to the notice of American engineers, notably Dr. Thomas Egleston, of the School of Mines, Columbia College, the latter brought it to the attention of the American Society of Mechanical Engineers at the annual meeting in November, 1884, and the result was the immediate appointment by the society of a "Committee on Uniform Standards in Methods of Testing Materials and of Test Specimens."* This committee first investigated the actual state of the art of testing materials in the United States by studying the methods pursued, and also had many duplicate tests of identical material made by all laboratories and engineers that could be induced to co-operate. The results were so incongruous, however, and the figures obtained were so variable and unreliable, that it was soon found that other methods would have to be adopted.†

In Europe, meantime, a number of important questions were agreed upon; certain others were referred to a standing committee, which considered them primarily by letter, and discussed them orally,‡ later, at two meetings held at Munich, September 21 and 22, 1885; and, finally, the results and conclusions were presented at the second general conference, held at Dresden, September 20 and 21, 1886. The latter concurred in most of the conclusions presented; but there remained a number of unsolved problems, which were intrusted to a second standing committee, whose duty it was to dis-

* Trans. A. S. M. E., Vol. VI., p. 359.

† *Ibi.*, Vol. XI., p. 604, *et seq.*

‡ The detailed report giving the transactions of the conference at Munich, and the constitution of its standing committee, are contained in the fifteenth part of "Mittheilungen aus dem mechanisch-technischen Laboratorium der technischen Hochschule München." Munich. Theo. Eckermann.

cuss them, and then present the findings to a third conference which met at Berlin, September 19 and 20, 1890, and at which a part of the problems were solved. The others, with new ones suggested by further study, were again returned to the standing committee, which was to report thereon at the fourth conference, to meet at Vienna. This last conference met on May 24 and 25, 1893, but again only a portion of the problems were considered solved, the others, besides additional new ones, being turned over to a fourth standing committee for further study. It was also decided that the chairman of this committee be authorized to issue a corrected and complete memorial, containing all the resolutions of the several conferences, similar to that issued in 1887.

The hope expressed in that memoir—that it “might keep alive the interest in the work of the conference, and might create it in such quarters as had kept out of touch with them”—has been fully realized.

Not only was the number of representatives from countries already interested (Germany, Austria-Hungary, Switzerland, and Russia) considerably augmented, but other countries (France, the United States, Norway, Holland, Italy, Belgium, and Spain) sent engineers; so that the conferences assumed a truly international character.

To further the growth of these conferences it was deemed necessary to state that each was a voluntary convention of men assembled for a free exchange of opinions upon the best methods or systems of testing particular materials which are to serve definite purposes. If resolutions are adopted at such conferences, they can decide only which method of procedure is considered the best by the majority of those present.

According to the first resolution of the first conference, “the discussions are to be free, and the resolutions not binding.” There are no obstacles to reconsideration of a question decided by a previous conference. Methods of testing cannot remain the same; they must be developed in accordance with our increasing knowledge of the properties of materials used in construction, with the improvements made in their production, with the adoption of new materials for the same, etc.

It, therefore, becomes necessary that those who take interest in testing materials, from a scientific standpoint, or because they are manufacturers or consumers, shall assemble from time to time, in order to deliberate afresh, exchange opinions, and mutually learn

and teach; and then, as a result of their deliberations, agree upon methods of testing which are by them, or at least by the majority, considered the most satisfactory for the time being.

The close relations existing between all civilized industrial countries, generated by constant intercommunication, would make the resolutions of such conferences of little value, if they were the expression of opinions of engineers in a few countries only. Hence the necessity that they should be international in character made itself felt, and led to their international development, though they were limited originally to Germany and a few neighboring States.

On the basis of these Resolutions of Conferences and the tests made for the committee of the American Society of mechanical Engineers, its committee prepared a report* and presented a translation of the Resolutions of Conferences,† and since that time it has kept in close touch with the work of the conferences.

By a presidential decree in France, dated November 9, 1891, a "Commission des methodes d'essai des materiaux de constructions" was created, having the same object as that pursued and developed by the Conferences of Munich, Dresden, Berlin, and Vienna, and their standing committees. Unquestionably official establishments of this nature have two distinct advantages over voluntary conferences: (1) they have greater authority, at least in their own country; (2) they control funds for extended series of special investigations, which may become necessary. They, however, have not an international character, which must be secured by some relation between the different governmental commissions, and they certainly have not those qualities, emphasized above, which are characteristic of voluntary conferences. The advantages of the latter, however, could still be enjoyed if the standing committees, working during the intervals between such conferences, were composed of voluntary industrial representatives, as well as delegates, of technical departments, authorities, societies, etc.

This French commission took part at the conferences of Zurich, in 1895, and Stockholm, in 1897. Although some of the problems proposed were solved in each interval, others sprang up to take their places, so that at the present time there are about twenty-one still unsolved. After the definite solution of some of the original abstract problems, those of a more distinctly practical character were taken up, so that at present the preparation of standard specifica-

* See Trans. A. S. M. E., Vol. XI., p. 604.

† Ibid., p. 527, also Vol. XIV., p. 125.

tions for properties, and inspection of materials, are among the more prominent.

At the conferences of Vienna and Zurich it became apparent that generally valuable results could be obtained only by international co-operation, which idea was finally adopted at the Zurich conference, and was carried into effect at the Stockholm conference, which became the first meeting of the International Association for Testing Materials. This produced an immediate accretion to the memberships, so that it seemed desirable, for the purpose of ready co-operation, to divide the association into national sections; consequently the memberships united themselves into auxiliary bodies, each being represented on the central council, whose seat is at Zurich.

In August, 1898, the American section of the International Association for Testing Materials was organized by selecting Prof. Mansfield Merriman, of Lehigh University, as president, and Mr. Richard L. Humphrey, in charge of the City Testing Laboratory, Philadelphia, as secretary.

Among the more important problems which are now before the Association, and which have been submitted to the various sub-committees for investigation, are those explained below. These sub-committees are international in character, each national section naming its representatives, selected from its membership according to their respective qualifications. As membership in the association and in these sub-committees is entirely voluntary, it is hoped that only such co-operation will be secured as is most likely to lead to satisfactory practical results.

The membership is composed of directors of testing laboratories, professors at schools of technology, engineers, railway officials, architects, foresters, and, last but not least, manufacturers of materials of all kinds. In addition to individuals, many organizations and governmental departments have voluntarily assumed membership, and military and naval officers of nearly all countries are regularly detailed to attend the deliberative sessions, and report the results of proceedings to their respective governments. The United States were represented at Zurich by an engineer officer, and at Stockholm by an officer from each of the engineer bureaus of the departments of the army and navy.

The International Association now has a membership of more than sixteen hundred, and of these more than one hundred are resident in the United States, forming the American section. The

growth of this section is rapid, and, if the manufacturers take as much interest in the objects of the association as now seems probable, it will become a very important body.

The primary object of the association is laid down in the second section of its statutes, as follows:

"The objects of the association are the development and unification of standard methods of tests for the determination of those qualities of materials of construction and others, which are of technological importance, and the perfection of apparatus used for that purpose."

This paragraph, in its broad interpretation, pre-supposes a complete study of all materials used by the engineer and artisan, not only as to methods of testing them, but also as to their properties. A study of methods of testing makes it imperative to learn the properties of materials, because a difference in method may, with materials of different properties, produce different results. Hence, while certain methods answer to obtain accurate knowledge of properties of some materials, they fail with others. This comparison of methods in their effects on tests of materials of different properties necessarily produces grouping of materials into classes. Therefore, the question of constituting characteristic classes of materials follows as a natural consequence; moreover, the ready identification of material with a particular group is closely connected with it. Hence the objects of the association must include, besides those directly stated in its statutes, the very practical subjects of specifications and inspection. In view of this explanation of the objects of the association, various new problems were proposed at the Stockholm congress, which are to be studied during the interim, and reported upon at the next congress, to be held at Paris during the international exposition.

The problems are divided into three groups,—viz.:

- I. Metals.
- II. Natural and Artificial Stone and Their Bond Materials.
- III. Other Materials.

These groups are presented and discussed at the congress, at the same time, in three sections, arranging themselves according to the preferences of individual members. The resolutions adopted by each section are then referred to the entire association in plenary session, and acted upon.

Under Group I. the following problems are now in course of study:

(1) Establishment of international standard methods of testing and inspecting iron and steel, based on specifications in actual use.

(2) Establishment of methods of determining uniformity of iron and steel, applicable for purposes of inspection.

(3) Study of the behavior of wrought iron at abnormally low temperatures.

(4) Study of investigation of welds and weldability.

(5) Collection of information as data for the establishment of standard methods for piece-tests, with special reference to axles, tires, springs, and cast and wrought-iron pipes, as well as parts of iron and steel construction.

(6) Study of the most appropriate method of polishing and etching for microscopic examination of the structure of wrought iron.

The problems of this group, especially Nos. 1 and 2, have appealed most strongly to the American section, which therefore has appointed special committees to study the subjects from a strictly practical point of view. This work is to be done independently of the international commission, by men closely connected with some of the largest American steel works, such as the Carnegie and Pennsylvania Steel Companies.

The problems of Group II. are as follows :

(7) Determination of the relation between chemical composition and weathering qualities of natural building stone. (a) Determination of the effect of gases of combustion, especially sulphurous acid. (b) Determination of methods of testing properties of slates, especially their weathering qualities.

(8) Determination of rapid methods of testing conditions of constancy of volume of hydraulic bond materials.

(9) How can the strength of hydraulic bond materials be determined rapidly?

(10) Testing the resolutions of conferences relating to the determination of adhesion of hydraulic bond materials.

(11) Preparation of uniform methods of testing puzzuolanas as to their value in mortars.

(12) Investigation of causes of abnormal setting of cements.

(13) Determination of conditions which will produce approximate equality of density of test briquettes and cubes for tension and crushing tests of cement.

(14) Determination of effect of sulphurous acid on artificial building stone, and on mortars.

(15) Study of the effect of sulphurous acid, in aqueous solution and in gaseous form, on mortars.

(16) Study of effect of sewage on the strength of hydraulic bond materials.

This group of problems clearly indicates how much really remains to be done in the way of determining the properties of mortars and cements before it can be stated whether certain brands are suitable for certain purposes. In a country like the United States, where the cement industry is comparatively new, these subjects are of especial importance; for if the methods of testing or determining their qualities are not even fixed, how can we be certain that the materials themselves are satisfactory? As a rule, tests of cements and mortars must extend over long periods of time before definite information can be obtained; hence the work of this group must extend over a number of years.

Group III. covers a wide field of materials used in all the arts and trades; whether tile or paper, silk or glue, glass or paint, everything is produced to obtain certain results, and sold under guaranties.

With this in mind, reliable methods of demonstrating that such materials fulfil the guarantees seem an absolute necessity; hence much attention is paid to them. Paper, for instance, is as carefully tested and inspected as iron and steel are; leather is generally tested with equal care; and the necessity of controlling the paint contractor need hardly be mentioned. Hence the following problems will be studied:

(17) Unification of methods of testing tile pipe.

(18) Establishing uniform methods of testing preservatives of iron structures against corrosion.

(19) Determination of bases for uniform methods of testing lubricating oils.

(20) How can ultimate appearance of dry rot (*merulius lacrymans*) be guarded against, while inspecting timber.

The eminently practical character of the work of the association is again shown by the last three problems. Any one who has had experience with dealers in lubricating oil and paint will readily recall the many infallible tests applied by each to prove the absolute worthlessness of the "other fellow's stuff," and the disappointment, expense, and accidents caused by the use of poor material—conscientiously applied, it may be—through lack of reliable methods of testing.

If the problems in Group I. and III. should be gradually solved by the Association, it would deserve the lasting thanks of manufac-

turers and engineers alike. The work is not like that of engineering societies, which are composed of non-homogeneous aggregations of specialists, publishers, and supply-dealers, too conservative to condemn or approve openly. The work of this association is mainly to establish bases for such condemnation or approval, applied by each individual for himself, according to his needs or condition. It does not deal with shades or grades of specialties, but with complete groups of material as such, with reference, not to their provenance, but mainly to their applicability and reliability.

It is not sought to make distinctions of any kind that may lead to antagonism or preference, as the association deals mainly with the abstract properties of material, not with the solution of engineering problems, more or less important locally.

Its relations are rather with trade than with abstract problems, for it helps to mutual understanding, among distant nations, of the qualities and sources of materials.

A complete and exhaustive demonstration to this association of the superior quality of American materials must certainly assist greatly in bringing about their general use in foreign countries, and for this reason it is hoped that American engineers and manufacturers will assist to the best of their abilities in the solution of the problems of the International Association for Testing Materials.

EDITORIAL COMMENT

As the monthly record of engineering progress, collected in the form of titles and abstracts in The Engineering Index, is examined as a whole, it is possible to see that the various departments of engineering are in so great measure dependent upon each other that any clearly defined division into departments and sections is impossible. The work of the civil engineer overlaps that of the architect on one side and of the mechanical engineer on the other, while electrical and mechanical engineering have become so closely connected as almost to be merged the one into the other.

An excellent example of this connection is seen in the revival of interest in masonry construction on the part of the civil engineer, with especial relation to the construction of masonry arches, while at the same time the mechanical engineer is meeting the weak point of masonry, i. e., its inability to resist tension, by the wholly *un-civil* method of imbedding structural-steel members in the mass of mason work. The marked interest in the subject of reinforced concrete, whether called by the name of Monier, Melan, Hennélique, or whoever else, is shown in numerous articles, all of which indicate the genuine interest of the practical constructor.

Closely allied to the interest in concrete construction are the papers relating to improvements in the manufacture of cement, showing the efforts which are being made by manufacturers in response to the demand for a product of continually higher grade.

A kindred branch of industry is that of effective methods of fire proofing, in which the interest aroused by recent disastrous fires, still continues keen and unabated.

* * *

The cessation of hostilities, so far as Spain and the United States are concerned, has had the natural effect of diminishing the number of articles upon purely military matters; but the interest which has previously been directed toward the engineer-

ing of destructiveness now appears to be expending itself upon matters of construction, still, however, in the department of fighting machinery. Plans for new battle ships, improved devices for rendering still greater the destructiveness of artillery, or for disabling the weapons of the enemy, are subjects of animated discussion and there is little doubt that engineers and mechanics, in various parts of the world, are all striving to render present methods and equipments antiquated and obsolete as rapidly as possible.

* * *

Another branch of engineering aggressiveness, and one which can be regarded with greater satisfaction, is the good work which is being done by the engineer in the exploitation of undeveloped portions of the globe. The Trans-Siberian railway, reports concerning which appear almost every month, is being pushed forward with determined energy. The bridge work over most of the great rivers is practically done, and the open secret that the true terminus is to be Port Arthur adds to the interest in this great undertaking. To this must be added the report of the commission upon the Inter-Continental railway, which may some day connect the railway systems of North and South America—a work which, however differently it may be regarded in various quarters, appears to be altogether feasible from the standpoint of the engineer.

* * *

The utilisation of natural sources of power continues to attract attention, and in this connection there appears a source of water power which can hardly be called *natural*, and for which a more appropriate name would be unexpected. The Chicago drainage canal, now nearing completion, is an artificial water way originally intended solely for the purpose of diverting the drainage of Chicago into the watershed of the Mississippi; but it now appears that the head thus developed produces a large amount of hydraulic power which only

needs the erection of a suitable power plant to be made immediately available. That this will be done there is no doubt, and, with the aid of electrical transmission, the energy of the canal will be delivered to Chicago or elsewhere.

* * *

As noted last month, the close connection of the engineer to the protection of public health continues to be the theme of many articles. It is becoming more and more evident that such a thing as a source of pure water, in quantity available for the enormous supply demanded by great cities, must not be expected; for such sources, even when found, cannot be controlled. For this reason the work of the physician, the bacteriologist, and above all, of the engineer must be directed toward the development of the best methods of rendering sewage harmless, before it is discharged into any stream which may afterwards be drawn upon as a source of water supply, as well as toward the provision of filtration methods and appliances for the purification of the water supply itself.

That this can be done is now a matter of scientific certainty, and in the accomplishment of this most important work the engineer has done his full share.

* * *

In the increasing domain of the applications of electricity there are no absolutely new features to be noted, but there are many positive indications that older methods of power transmission must rapidly give way to the electric current. In the machine works both belting and shafting will soon become obsolete, and every month evidence of this transformation appears, while even on that most conservative of all places, the farm, we hear of electric ploughing, threshing, and even sheep-shearing. Electric traction continues to absorb its full share of space allotted in the columns of the Index, and indications are not lacking of the application of electric power to main-line railways.

Within the especial domain of the mechanical engineer there has been quietly developing for several years past a transformation in practice and methods which is only gradually being indicated by the articles on tools and methods which appear from time to time. From being a place

where everything can be made in any sort of a way, the machine shop is becoming a place where very definite products are made in a most systematic manner. Specialisation is the order of the day, in products, operations, tools, and men, and the works which attempts to continue along the old lines may soon find that there are no old lines to follow, that which was merely old having suddenly become obsolete. Articles upon works, organisation, factory accounting, the design of special machinery, the use of special tools—these and many others are but surface straws upon a quiet but powerful current which is cutting a new channel that may leave many of the old landmarks on one side.

* * *

Public works form the subjects of numerous papers of interest, especially in the United States. The isthmian canal still remains unsettled as to location, and the rival claims of Panama and Nicaragua must undergo the ordeal of critical investigation under the action of Congress. It is to be hoped that the impartial investigation of the engineer will be permitted to guide in a matter of such world-wide importance, and that it may be wholly removed from the domain of politics under which it has so long languished.

The necessity for the construction of important dry-docks in the United States has led prominent engineers, both in and out of the government service, to protest against the building of any more timber docks, and the effective manner in which the superior economy of masonry construction has been set forth should prove an effective answer to any claims made for the timber docks on that score. The penny wise pound foolish policy certainly should not be permitted to prevail in a case where the true interests of the service are so clearly apparent.

* * *

Electric lighting continues to make progress, and that, too, along lines where it was least expected. For some time there has been much effort and ability directed toward the improvement of the arc lamp, with the result of the production of the enclosed arc and other minor features; but the allied field of incandescent lighting has until very recently shown little or no ad-

vance. The advent of an unenclosed incandescent lamp of long life, high efficiency, and great flexibility marks an epoch in electric lighting, and the invention of Professor Nernst, reviewed elsewhere at length, forms the subject of one of the notable papers of the month. From Germany also comes another invention in the domain of electricity in the form of a remarkable current-interrupter, utilising a hitherto unappreciated fact in electrolysis, and this invention of Professor Wehnelt bids fair to effect a great increase in the capacity of induction coils, and in the generation of currents available for advanced researches in radiography.

Altogether the month has been a busy one, both for the investigators and the recorders, and in the columns of the *Engineering Index* may be found the record of the records, for those who wish to follow the progress of the profession as a whole.

* * *

The Pratt & Whitney Co. have addressed to Mr. Norris and to the Magazine a further explanation of their method of valuing standard drawings, which quite removes any ground for the implied criticism expressed by Mr. Norris on page 817 of our February issue. To the question "How do you value your standard drawings?" their reply was "At cost some years ago, and have, since this item of cost was established, let it remain at the same figure, with year additions of not less than \$12,000 to \$15,000." Interpreting this to mean that \$12,000 to \$15,000 was added yearly to the original cost valuation of the drawings, in making the inventory, Mr. Norris criticised vigorously any policy which classed as "pure, unshrinkable capital" a class of equipment so clearly a "means to an end,—a necessary evil in production" as are standard drawings.

The meaning which the answer was intended to bear, however, is that, while drawings costing \$12,000 to \$15,000 are added each year, the total valuation is nevertheless kept at the original figure fixed several years ago, without any addition to the inventory for these large yearly expenditures. They are practically assumed merely to offset the depreciation of the existing equipment. Granting, as Mr. Norris does, the propriety of considering

standard drawings an asset, this is providing a very safe factor of depreciation.

In the light of the explanation, the original statement is quite clear. Probably, however, most of our readers have interpreted it as Mr. Norris did, and we are happy to correct an unfortunate misconception and to withdraw, for Mr. Norris, a criticism which is evidently unmerited so far as the Pratt & Whitney Co. is concerned.

* * *

The movement toward trust-forming in the United States—long since unreasonable—is taking on a rate which threatens to be uncontrollable and to end in plunging the country to a financial and industrial crash.

It is a curious, and apparently contagious mania which has seized the American manufacturer. The great wit of his economy has passed into madness. Granting that much may be said in favor of singleness of management, of the economy of manufacturing on a vast scale—of the elimination of useless duplication of plant and of managers—the cases where the arguments apply are few and, even in these, the application is usually limited.

The trust will succeed and persist only so far as it aids in cheapening production and distribution and, by reasonable sharing of the benefit, increases consumption proportionately. This is the natural evolution of manufacture and trade, and, as the firm has sometimes advantage over the individual, and the corporation over the firm, still larger consolidations may be "indicated," as the doctors say, in certain cases.

But a mere agglomeration of manufacturing units effecting no important savings in processes or in direction, and stimulated only by the hope of unusual profit through stifling of competition and an artificial control of the market, is economically immoral and a menace to the community and the nation.

Of this sort are many of the recently announced American "trusts"—weeds of an overstimulated financial soil and the artificial atmosphere of a high tariff. There seems to be no course to follow but that of the Master of the wheat and the tares: "Let both grow together until the har-

vest;" out of the threshings and chaff-burnings of an industrial panic the sound growth of true enterprise will endure, but the fruit of the trust-promoter will be known by the bitterness of its ashes.

* * *

The passage, by the United States Congress, of the Naval Personnel bill is an official recognition of the status of the engineer in a quarter in which the combined force of military and sea traditions seemed almost hopelessly strong against it.

It is far more than a matter of title and shoulder straps—more than the establishment of the plainly necessary right to command, and the removal of the anomalous state which permitted the attempt to put a staff officer under the orders of an enlisted man. It is a reorganisation of the navy in recognition of the fact that the war-ship is a vast engineering establishment—that every movement of the vessel and every exercise of every function is made by mechanical power, and that all her officers must be engineers if the highest efficiency is to be had.

The bill abolishes the old distinction of "line and staff" and merges all in one homogeneous body, the present engineer corps receiving actual rank and title and the line officers becoming engineers, to the extent, at least, of the abolition of a distinct body whose knowledge and duties are confined to the deck and the guns.

In the lower grades, however, provision is made for a good number of "warrant-machinists," similar to the artificer engineers of the British navy, whose functions, like those of boatswains and gunners, will be closely specialised.

The measure seems to be wisely general in its provisions for gradual accommodations of the service to the change. The older men will not be required to change their province; the "middlers" have an option as to continuing their specialisation; the younger men are to be trained up in the new order.

There is nothing to prevent the development of natural aptitude or inclination for particular work, whether it be navigation,

ordnance, or the engine-room. In the main, however, the same man will be fully competent to stand watch at the engines, on the bridge, or at the battery.

The result will be enormously beneficial to the service, and cannot fail to have a large influence in the British navy, where a similar measure is sought by the engineers, with small prospect of success.

* * *

It is extremely gratifying to see that sound judgment has asserted itself in a matter so important as the espousal, by the United States, of the American isthmian-canal project. Even up to the time of our last issue the matter was in doubt. The leaning toward a hasty adoption of the Nicaragua route seemed so strong that one hardly dared hope for a patient hearing of the whole case, even though provision for the consideration of "some other route" was carried in the Senate bill.

The House, however, justified our forecast, and the provision made, as a result of their attitude, is as near as the present state of political feeling would permit to the ideal sketched by Mr. Hunter in our March number. It provides, in brief, not for acquisition or construction, but for thorough investigation, appropriating therefor the sum of \$1,000,000.

It seems probable, from the reports, that the agreement was reached because the House and Senate conferrees respectively construed it differently—the former as committing the Government to nothing beyond the immediate provision, and the latter as binding the United States, by implication, to the construction of a canal.

The commission of examination will not be international, but it may be considered certain it will be impartial. It is suggested the President may enlarge and continue the Walker board, which has not yet completed its work on the Nicaragua surveys. At all events, the danger of a stampede seems to be passed. With ample funds, sufficient time, and a competent commission of high character and ability, the facts will be made clear. In the interest of the engineering, the maritime, and the commercial world, may the best route win!

THE BRITISH PRESS

Review of Leading Articles

The Study of Alloys.

THE development of the modern methods of studying the chemical and physical characteristics of metallic alloys has been very rapid during the past few years, and since 1891 the work of the Alloys Research Committee of the Institution of Mechanical Engineers has contributed materially to the knowledge of the real reasons for the behaviour of alloys.

The fifth report of the committee, recently presented by Sir W. C. Roberts-Austen, contains much interesting matter, and is devoted to the behaviour and constitution of steel, with particular regard to the conditions which exist during cooling and solidifying.

The real nature of steel is a matter which has been much discussed, and about which much uncertainty yet exists, but the results of the most careful observations seems to indicate that the solution theory, i. e., that the carbon is dissolved in iron, much as salt may be dissolved in water, explains the behaviour better than any other hypothesis.

The best way in which the action of iron and carbon in forming steel can be explained, is by comparison with the phenomena which occur during the freezing of a solution of salt in water.

If a thermometer is placed in a ten per cent. solution of salt in water, and the temperature is gradually lowered, the mercury will cease falling at about 18° F., at which point the separation of pure salt-free ice will take place. The mercury will then continue to fall until at a temperature of -8° F., the so-called eutectic, or lowest liquid point, is reached, and the ice and salt solidify together. This solid mass then consists of crystals of ice and of salt merely in contact with each other. As the degree of concentration of salt in the original solution increases, the initial freezing point will be lower and lower, the second freezing point always remaining constant at -8 F., and when the solution contains 23.5 per cent. of salt, both freezing points coincide at -8 F.

If now the solidification of melted steel, or iron with carbon in solution, is considered, the solidifying being practically the freezing of the alloy, a similar action takes place. As the iron solidifies, a portion of the carbon separates out as graphite, while on further solidification a solid solution of iron and carbon is formed, these actions depending upon the percentage of carbon present in the steel, and upon the rate of cooling.

It is impossible to discuss here the various combinations observed with steels and irons of different composition and character, but the admirable illustrations accompanying the original report show how well the characteristic features of the alloys can be detected by the use of the microscope.

By the study of polished and etched sections of rails and other steels under the microscope, it is seen that the metal appears as a rock with various minerals distributed through it, and, since the different kinds of crystals are differently attacked by the etching solutions, their form and distribution can be very clearly brought out.

The effect of rapid cooling, as in the operation of hardening, is especially instructive, the form and character of the constituents varying very materially according to the rapidity and degree of cooling. Some very interesting micro-photographs are shown of specimens heated to a temperature of 1,832° F., and quenched in liquid air at a temperature of -328° F., the physical structure being very clearly brought out.

The practical applications of these highly scientific researches are already being brought out by the study of the structure of steel rails, as compared with their behaviour in actual service, and there is every evidence that the simple operation of polishing and etching properly selected sections, and a microscopical examination, may hereafter be the powerful auxiliary of the chemical laboratory and the testing machine.

The Nernst Lamp.

FOR some time there have been brief notes in the Continental papers about the improved incandescent lamp invented by Professor Nernst, and these have been supplemented by a full paper on the subject, read before the Society of Arts by Mr. James Swinburne.

Before proceeding to the main subject of his paper Mr. Swinburne makes some remarks about incandescent lamps in general, with especial reference to their low efficiency, and to the small progress which has been made in them during the past fifteen years.

"Considering the enormous importance of the incandescent lamp, its improvement has received extraordinary little attention. It limits us as regards pressure, it used to hamper us by its cost, and it limits us very seriously by its inefficiency. Of course mere detail improvement in manufacture has taken place, and this has led to better quality and greater uniformity, hence cheapness; but there has been no radical improvement."

There is, therefore, room for an improved incandescent lamp, and it is in the line of improvement that Nernst has been working.

The principle of the Nernst lamp is simple, as it depends entirely upon the fact that the hotter we can make an incandescent body, the higher its efficiency will be. There is a limit to the temperature at which a carbon filament can be used, since it has a low specific resistance and is also long and slender. Nernst has therefore chosen a material of which the exact composition is not given, but which is composed of highly refractory oxide, presumably of some of the metals of the alkaline earths, using a short rod mounted between platinum wires and supported in a holder. In addition to being highly refractory the material is also of high specific resistance so that it can be made quite strong, and as there is no combustion to take place, there is no need for an enclosing bulb or vacuum.

Since the rod, when cold, is an insulator, the lamp cannot be lighted merely by turning on the current, but requires the use of some external source of heat, such as a match or preferably a spirit lamp to start

it. When the rod is warmed the current flows and when thus started the lamp soon attains a high degree of brilliancy. As the heated rod is a electrolytic conductor there is a gradual wasting away, which cannot be checked by enclosing it in a vacuum bulb, but the rods as at present constituted have a life of more than 500 hours and it is expected that this will be greatly extended as experience in their manufacture is gained. When the rod is worn out a new rod with its wire mounts is all that is replaced, and the whole lamp is not thrown away at all.

The principal objection to the Nernst lamp is the necessity of lighting it with a match, so to speak, and the ordinary incandescent lamp has demonstrated so fully the desirability of the self-lighting feature, that the necessity of retaining this point has been felt.

Modifications of a device utilising a heating resistance, which is cut out after the current flows through the rod have been found applicable when automatic ignition is considered necessary, and either with or without such an attachment the invention of Professor Nernst provides a high-efficiency incandescent lamp capable of being operated at high pressures, and furnishing an agreeable and manageable light at moderate cost.

In discussing the possibilities of the system Mr. Swinburne calls attention to the great desirability of an incandescent lamp for use with high pressures and consequently smaller conductors, while as compared to arc lamps the Nernst lamp will be very much cheaper in first cost and enormously cheaper in maintenance. Large lamps can be made to work in parallel at 500 volts, and by using double rods, at 1,000 volts, thus putting an entirely new development in electric lighting in the hands of the engineer.

In the discussion on Mr. Swinburne's paper attention was called to the fact that in the early Jablochhoff candle there was a strip of kaolin between the two carbons, which became incandescent, and added very materially to the luminous power of the lamp, while in the so-called "Lampe Soleil" an arc was struck across a surface of marble which ultimately became incandescent; but both of these used the refractory material as an auxiliary to an arc

between carbons, and both have become obsolete for very obvious reasons.

While the Nernst lamp is hardly yet in the commercial stage it will undoubtedly be given every opportunity to demonstrate its practical utility and value, and at the present time it certainly appears as if an important addition to the application of electricity to illuminating purposes has been made.

Steam Automobiles.

ALTHOUGH the advent of the modern automobile vehicle is largely due to the advances which have been made in the storage of electric energy and in the improvements in internal combustion motors, yet for many reasons steam is still an important and valuable medium for motive power for such vehicles, and with recent improvements in light weight generators and engines it has many claims to consideration, especially in connection with the heavier class of automobiles.

A paper upon the application of steam to self-contained road vehicles was recently read before the Liverpool Traffic Association by Mr. W. Norris, in which the conditions of road driving as affecting steam machinery are discussed, and a number of interesting points emphasised.

In the eyes of many engineers steam has numerous advantages, especially when one may be away from home, or from convenient access to a repair shop or charging station, and when, as is usually the case, liquid fuel is used, a fresh supply may be procured at almost any country shop.

An engine, to be well adapted for motor-vehicle purposes must, of course, be constructed so as to meet, as far as possible, the very exacting requirements. The lightest possible construction must be combined with the greatest possible strength and simplicity, the bearing surfaces must be ample, the rotative speed high, and the valves adapted for the high pressure which must be used. The working parts should be protected from dust, and yet readily accessible when necessary, and careful balancing and smooth and quiet running are most essential. If a high fuel and water economy is expected, it is important that the engine be constructed to run at a constant speed, a system of reduction and

change gears being employed for changes in speed.

Equally important with the engine is the boiler, and as light weight must be combined with strength to resist high pressures, and with ample heating surface, much care is required in its design.

The capacity and economy of the boiler will depend very much upon the area of its effective heating surface, and when it is considered that only a portion of the surface is in direct contact with the flame, and that it is practically impossible to transmit a uniform degree of heat to the various portions of the surface, it will be seen that the disposition of the surface is of as much consequence as its extent. In the case of oil fuel the arrangement of the burner with regard to the heating surface is also important, since some of the tubes may be almost ineffective so far as steam generation is concerned, if the flame and hot gases do not reach them properly. The value of a unit of heating surface depends mainly upon the relative position and direction in which the current of heated products obtains contact with the metallic surfaces.

Many of the questions involved in automobile construction are independent of the character of the motive power, and among these one of the most important discussed by Mr. Norris is that of the wheels. Although his remarks are mainly intended to refer to wheels for heavy road vehicles they apply in many points to wheels for automobiles of all kinds.

The great difference between the wheel for a motor vehicle and a waggon which is to be hauled lies in the fact that one drives and the other is driven. In a vehicle which is hauled by horses the wheels act mainly as supports and are pulled forward by a force applied at the centre, while the turning force is applied at the rim. In a motor vehicle, on the contrary it is the turning force which is applied at the hub, tending to twist it around within the spokes, and thus causing a great strain upon the wheel in a manner which is difficult to resist. It has not been found practicable to make a wooden wheel which will stand the wear and tear for any length of time, and although steel wheels of satisfactory strength have been designed yet they are

heavier than wooden wheels if made strong enough for the service. Broad tyres are desirable not only for the protection of the road but also for ease of running and durability of the wheel, so that the best wheel is by no means the handsomest.

Mr. Norris's paper will undoubtedly call attention to the fact that steam is yet and probably will continue to be a strong competitor of the electric accumulator and the petroleum motor for automobile propulsion, and while the ultimate determination of the best source of power has not yet been attained, there is ample reason to believe that steam will maintain an excellent showing for heavy-weight vehicles at least, and possibly for lighter ones.

The Construction of Ocean Steamers.

THE continual increase in size exhibited by the successive productions of the ship builder's art has involved some important modifications in structural features, and as some of these modifications are directly connected with the arrangement of the propelling machinery the two problems of hull construction and machinery are closely allied.

In a recent editorial in *The Engineer* this subject is discussed at length and some points of importance brought out.

As in many other cases, the controlling conditions for small structures become subject to material modifications as the dimensions increase, the changes being due not only to the increase of stresses with increased dimensions but also to the demand for greater proportional space for the engines and boilers.

"A comparison made between the framework of an ordinary tramp and that of an up-to-date trans-Atlantic greyhound will show several marked differences. The newer and better class of tramp has generally a deep and capacious hold, with two steel decks and no more than two tiers of beams. She has the minimum number of transverse water-tight bulkheads required for classification purposes; these ranging in number from four to six. To secure deep and lengthy hold spaces, tiers of beams must be omitted which would otherwise have been fitted, and the necessary transverse strength is supplied by means of deep girder frames, or web

frames, in each case associated with strong hold-stringers.

"Within certain limits of size such vessels may be, and are, made thoroughly strong and efficient, as is shown by the excellent way in which they regularly do the work to which they are put. But when these dimensions are exceeded, and the engine power is placed in them necessary for the attainment of great speed, vessels require other and more complex structural arrangements; and when they have further to transport a thousand passengers across the Atlantic at all seasons in the year, with the nearest approach to absolute safety which it is in human power to attain, then still further structural additions have to be provided."

On the passenger steamer more decks and more bulkheads are required than on the tramp, both for structural purposes and also to provide for the increased cabin accommodation, but at the same time the large space demanded in what is practically the weakest portion of the vessel for the machinery interferes very materially with the marine architect's plans. Anyone who has gazed down the great well in which the twin screw engines of a modern liner are placed should realise that all that mass of machinery absolutely precludes the best framing of that portion of the vessel, and makes the problem of compensating for the omission of normal structural arrangements most difficult.

The soundness and efficiency of the great modern liners in actual service demonstrate that these difficult requirements have been successfully met, so that, notwithstanding the conflicting conditions, the modern passenger steamer is amply capable, from a structural point of view, of resisting the heavy stresses to which she may be subjected.

It has sometimes been thought that vibration in a vessel is an indication of structural weakness, but this is often not the case. Vibration is largely a question of synchronism of the beat of the engines with the vibratory period of the hull, and a moderate change in the speed of the engine is often sufficient to destroy the pulsations. The speed at which one vessel vibrates most is that at which another of different form and dimensions is the stead-

iest, and in many cases an increase of engine speed diminishes the vibrations.

There is no product of the work of the engineer more worthy of study and patience than the relation of the motive power of a vessel to the construction of the hull, and while as yet the question of the relation of the period of engine beat to the dimension and shape of hull to produce or avoid vibration can as yet only be determined after construction and remedied by subsequent measures, there is no reason why this should always be the case.

Much has been done to reduce the initial vibration of the engine itself, and the problems of counterbalancing have been solved to a great extent, but the greater problem of the relations of the pulsations of the engines to the vibrations of the hull still invites study and experiment.

Tests of Timber Trusses.

THE influence of precedent and authority in engineering work must of necessity be great, especially in connection with government and official work, where any attempt at innovation is discouraged and departure from established rules regarded almost as a breach of discipline. An excellent illustration of the extent to which this sort of thing may be carried is seen in Major Scott-Moncrieff's excellent paper on tests of full-sized timber trusses, published in the *Journal of the Royal Institute of British Architects*, and discussing experiments made under his supervision at the School of Military Engineering, Chatham.

Early in the present century Tredgold wrote his monumental treatise on carpentry, and while there is much in the work which is undoubtedly yet of great value,—the knowledge of the strength of materials and of the action of stresses and strains was by no means as thoroughly understood then as now, and many of the rules and proportions were obtained empirically, or taken from successful practice.

Among other things Tredgold devoted a few brief paragraphs to the construction and proportions of timber roof-trusses, and upon these rules the whole of subsequent English practice has been based, the work having been adopted by the Engineer Department of the Army in 1844, and ranking as standard authority ever since.

An examination of the proportions given by Tredgold for timber trusses, however, indicates at once that they are by no means the best, or most economical that can be adopted. Thus he makes the tie beam much heavier than the principal rafters, notwithstanding the fact that under any conditions of loading the stress upon the latter must be the greater, while the arrangement of struts and the location of the purlins are such as in certain cases to cause eccentric stresses.

Believing that the empirical proportions generally used on Tredgold's authority might be successfully replaced by formulæ based upon a rational treatment, Major Scott-Moncrieff decided to make a series of comparative tests of full-sized trusses, using both the proportions given by Tredgold and those indicated by a consideration of the theoretical distribution of the stresses. As these tests were made upon trusses of 24 to 32 feet span, the results are worthy of especial note, since so many of the tests of timber upon which elaborate discussions have been based consist of trials of such small pieces as to render them of doubtful value.

The apparatus used was simple, and apparently very effective, consisting of hydraulic jacks applied at the purlin bearing-points upon the principals, the jacks reacting against a heavy steel beam to which the ends of the truss under test were also tied by sling-bars. The pressure exerted by the jacks at any moment was indicated by a pressure gauge mounted upon a reduction cylinder, the ram of the cylinder having an area of 50 square inches, so that each pound on the dial corresponded to 50 pounds actual pressure on the cylinder.

The tests demonstrated a number of facts which corresponded closely with the theoretical deductions. Thus in the case of a 28-foot king post truss, made not after Tredgold's proportions, but with tie beam and principals of the same dimensions, failure occurred, not by the yielding of either member as a whole, but by the shearing of the end of the tie beam because of the defective character of the joint. A 28-foot truss, made exactly according to the proportions given by Tredgold, failed by the buckling and splitting of one of the prin-

cipals, the struts also giving way, thus demonstrating the insufficient proportions of the compression members. Similar tests with queen-post trusses, and with modified proportions, sustained very generally the reasoning upon which the trials were undertaken, and while the number of tests was too limited to warrant broad conclusions to be drawn, the results were very satisfactory so far as they went.

The conditions of trial were not altogether identical with those which obtain in an actual roof, since the several trusses in a roof are stiffened against lateral buckling by the purlins. The tendency to lateral deflection was observed to a marked extent in some of the tests, and the desirability of introducing carefully designed lateral bracing between trusses was demonstrated, as was also the importance of providing means for tightening the various joints at will.

Altogether this work has resulted in furnishing some valuable contributions to our knowledge of the behavior of wooden trusses under load, and incidentally has shown on how insufficient a foundation some of the respect which is paid to a fine old crusted authority may be based.

Spontaneous Combustion in Coal Mines.

ALTHOUGH the fact that coal under certain conditions is liable to spontaneous ignition has been known for a long time, there is yet a difference of opinion as to the true cause of such action, or to the best precautionary measures to be taken.

In a paper by Mr. James Ashworth in a recent issue of the *Colliery Guardian* the relation between moisture and spontaneous combustion is discussed, and a possible cause for the ignition examined.

"Formerly it was thought that the oxidation of iron pyrites was the cause of spontaneous combustion in coal mines, but it was evident that this by itself was not sufficient cause, because it was noticed that some mines which contained large percentages of pyrites did not take fire spontaneously. Investigation has proved, and it is now generally admitted, that the absorption of oxygen by the very fine coal dust is the principal cause of spontaneous combustion in coal mines, but it is not so generally admitted that the dampness or dry-

ness of the mine air-current has as much influence on the development of spontaneous combustion as the absorption of oxygen only."

This fact at once brings about a complication of affairs, for in order to prevent the propagation of explosions through dusty mines it has become a very general practice to sprinkle them, or to moisten the coal in some other way, and thus, while preventing the dispersion of dust to set up the most favourable conditions for spontaneous combustion.

Dust explosions are properly regarded as very serious, and every precaution should be taken for their prevention. The principal methods in use are those which include various systems of watering the coal, either by forcing water into holes bored into the seams, or by watering the coal freely in the trams; or else some method of fine sprinkling or spraying is employed. Another plan is to provide thoroughly wetted spaces or zones at intervals along the haulage roads, thus furnishing areas free from dust, through which explosions cannot be propagated.

So far as the action of moisture upon the ignition of coal is concerned, it appears, from the most careful experiments which have been made, that coal dust readily absorbs oxygen and water, and that the oxidising of the coal creates heat. If this heat does not exceed 250° F., spontaneous combustion will not take place, but if it reaches 356° F., the heat rises very rapidly and quickly fires the coal, and if, while the coal is exposed to a heat of 290° F., the air surrounding the coal is suddenly compressed, ignition will take place at once, and the combustion will be very fierce. Where the air of the mine is warm and damp, therefore, the margin of defence against fire is very small, and it is desirable that a thorough ventilation with a cool and dry air current should be maintained. When the workings are inclined the air current should be conducted down-hill instead of up-hill, in order to prevent the accumulation of heat and aqueous vapour otherwise found in the working places at the highest point of the face.

Apart from the danger of ignition, due to spraying the dust with water, the fact appears that water-spraying does not act

effectively to prevent dust explosions. Numerous examples of dust explosions have been observed in mines in which the workings were sprayed with water, and in investigating such explosions, as has been most thoroughly done by the Prussian Firedamp Commission in connection with dust explosions in Westphalia, it was demonstrated that the only means of arresting or preventing an explosion of coal dust from a blown-out shot is by wetting the dust with 50 per cent. of water, or, in other words, making it so wet that water may be squeezed out of it by the hand.

These facts indicate that a thorough wetting must be used to prevent dust explosions, and at the same time that dampening which permits the oxidising and overheating must be avoided so far as possible. These somewhat contradictory requirements are met as well as can be expected by the use of wetted zones or lengths of road not less than 70 yards in length. Experiments have shown that protected spaces of this character are sufficient to prevent the passage of an explosion, and by a judicious arrangement of these zones any dust explosion may be confined within the limits of its origin. The remainder of the mine need not be moistened at all, while these wetted sections can be kept wet enough to avoid overheating and can be watched for possible ignition more readily than with a general system of sprinkling.

"The more this subject is investigated the more clearly it will be demonstrated that it is not wise to water a mine which is subject to spontaneous combustion, and that a very dry and cool ventilative air-current is the best safeguard against spontaneous combustion and explosion from coal dust, and that until some better means of rendering a coal mine safe against an explosion of coal dust is discovered, a wet length of road or zone is the best protection."

Steam Speeds at Sea.

IN the Watt anniversary lecture, delivered by Sir Nathaniel Barnaby in Greenock before the Watt Institute, the development of the speed of steam vessels is treated in an interesting manner, and some points in connection with recent advances especially discussed.

Mr. Scott Russell gave the Watt lecture in 1867, and Sir Nathaniel took occasion to compare the present state of steam navigation with that set forth thirty-two years ago. Not only has the steam tonnage, both in the merchant marine and in the navy, increased more than six-fold, but steam pressures have increased from 30 pounds to nearly 300 pounds. Piston speeds have been raised from 500 to 900 feet per minute, and the revolutions of the screw propeller have been increased in large ships from 75 per minute to 120, and in small vessels to over 400 per minute.

Thirty-two years ago the crack Cunarder was the *Russia*, and with 3,100 horse power she required three pounds of coal per horse power. The Cunarders of to-day develop nine times as much power, while the consumption of coal per unit of power has been reduced to two-thirds that of the *Russia*. The maximum speed attainable at the beginning of the present reign was 14 knots, while at the present time 34 knots has been attained on actual trial, and that too with a small vessel.

One of the most serious limitations which has been found of late to further increase of speed is the reduction in the efficiency of the screw propeller at high speeds, and this fact, first brought out by Mr. Thornycroft in the trials of the *Daring*, led Mr. Parsons to use three shafts and nine propellers on the *Turbinia*. In applying the Parsons steam turbine to a large passenger vessel or war ship, using say, 30,000 horse power, it is estimated that four propeller shafts with two screws on each shaft would be necessary.

The original fashion for high speeds was set by the Armstrong firm in building some vessels for weak foreign navies in which speed was of great importance. Between 1880 and 1882 several vessels were built for China and for other countries, the most notable being the *Esmeralda*, which made 18¼ knots, and the *Esmeralda* type, sometimes with a narrow strip of side armour, but more often with none, was the beginning of the swift cruiser class now in high favour in all navies.

The experiences which have been had with modern swift vessels show that the behaviour of the water resistance undergoes a peculiar change after a certain point is

passed. The propelling power of a ship is largely expended in making trains of waves, and within certain limits the wave-making expenditure increases at a very rapid rate as the speed of the ship is increased. When the limit is reached there is an apparent change in the behaviour of the fluid through which the vessel is being forced, and the rate of increase in resistance is much less rapid.

In a vessel 185 feet long this change for the better begins at a speed of 24 knots, but for a vessel 500 feet long no improvement due to this action can be expected until she attains a speed of more than 100 knots, were such possible.

This accounts in part for the remarkable results which have been attained of late by small vessels, and precludes the possibility of such speeds being reached by larger vessels. The present tendency toward the building of large vessels is therefore to be expected to yield excellent results as to stability, comfort and capacity, but the very high speeds of the immediate future will in all probability be attained by the smaller ships.

The Protection of Iron from Rust.

It is generally considered that the only thing needful for the full protection of iron is the prevention of contact with moisture, and therefore any paint which will adhere to the iron and will repel water is assumed to be a sufficient precaution. An exhaustive paper in a recent number of *Engineering*, shows, however, that not infrequently the paint itself may contain, or produce corrosive agents which may injure the very structure they are to protect.

One of the simplest and most generally used paints is discussed, i. e., a mixture of pigment, such as red oxide of lead (red lead), or red oxide of iron, with linseed oil. Such a mixture is practically the same as a soap, similar in all respects to a soap made by mixing an alkali with an oil or fat. Now, linseed oil consists of several organic acids, and of the radicle from which glycerine is formed and when the glycerine is eliminated by boiling with an oxide, the fatty acids are in a suitable condition to become oxidised into tough elastic skins.

If these simple chemical reactions could

be perfectly carried out, the production of a good protective paint would be a simple matter, but in fact it is difficult to insure the complete separation of all the glycerine. Instead, therefore, of removing all the glycerine, it is attempted to render it harmless by absorbing it in some material for which it has an affinity. Such absorbing materials are found in oxide of lead, oxide of iron, or various resinates, etc., which are generally used in protective paints. In some paints the free glycerine is absorbed to a large extent; for example in red-lead paint the free glycerine is absorbed to the extent of seven-eighths, and in red oxide of iron it is absorbed to the extent of three-quarters, but in no paint is it completely absorbed, and in an effective protecting paint, therefore, some special substance must be used to complete the absorption.

"The compounds known as driers or siccatifs, which are added to paint for the express purpose of quickening the drying or hardening process absorb the pure glycerine. As a matter of fact, these driers are more often than not, compounds, which also, by decomposition, eliminate glycerine, particularly so those driers which are made by boiling litharge with linseed oil. Those driers which are compounds of manganese salts, or else resinates, are the most perfect compounds for absorbing—and therefore preventing mischief arising from—the glycerine."

The danger which arises from the use of a so-called protective paint which contains free glycerine, lies in the insidious manner in which it eats into the metal. The paint may appear all right, and may form a hard, smooth, and apparently impermeable coating upon the metallic surface which it is intended to protect, while at the same time it may contain in its substance, beneath the outer skin, a material which, being gradually released, is most corrosive in its action. In addition to the oxidation which the glycerine causes in the iron, it also causes the formation of blisters, and by reason of its affinity for water, it produces water-filled blisters, which gradually push up the paint and cause it to flake off. It is most essential, therefore, in the selection of a paint for the protection of structural works of iron or steel, to look for this most dangerous foe, glycerine.

THE CONTINENTAL PRESS

Review of Leading Articles

Electricity in Agriculture.

A VERY interesting review of the progress of the application of electricity in the various branches of farm work, with especial reference to recent experiments in Germany, is given by M. Paul Renaud in a recent issue of the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, with many illustrations and data about this somewhat neglected branch of applied electricity.

It is only on the large farms that steam-power machinery can be installed to advantage, the intermittent character of the work and the high cost of the plant render it impracticable for small places; but, when power can be distributed from central stations to agricultural districts within a considerable radius at a reasonable cost, it can be utilized in many effective ways.

The production of the current for use in agricultural districts may be accomplished in various ways, being influenced mainly by local conditions. When waterpower is available, it can generally be used to much advantage; otherwise steam, oil, or gas engines are employed. Use of wind power in connection with accumulators has been suggested, but the extremely irregular character of this motive power has caused it to be used only in a few experimental instances.

In practice thus far the continuous current has been most extensively used, but at present applications are being made of the high-tension alternating current, using transformers at the points of application, and three-phase currents are strongly recommended by M. Renaud.

On the farm, as elsewhere, the main applications of electricity are for power and for lighting, but the peculiar nature of the work renders special appliances and methods necessary. Much of the work on a farm not only is out of doors, but also is distributed over a large area, requiring portable machinery and ease of manipulation and transportation.

Naturally one of the most important ap-

plications of power in agricultural work is that of plowing, and much space is given to descriptions of various forms of electrically-driven plows. In this line of work little has been done, except to substitute electricity for steam power in connection with forms of machine-plows already in use. Cable-drawn plows are much better adapted for general work than those hauled by traction engines, and the only difference between steam and electric plows is the substitution of a truck with motor, gearing, and suitable winding drum, for the portable engine otherwise used. Plans are shown of the manner in which electric power may be distributed from a central point to plowing-machinery in a number of fields at the same time; and, by the use of electric cables carried upon portable drums temporary connections may readily be made from a central distribution point to fields within a reasonable distance.

Another very useful application of electricity in agriculture is that of traction. Hauling by steam power has never been very practicable in connection with farm work, but, when electric power is available, it is possible to install, at moderate cost, a system of light railways, connecting the various buildings and fields, and, by means of an overhead trolley, to do most of the hauling by power.

Agricultural trolley roads of this sort have been established with much success in Holland, in connection with the cultivation of the sugar beet; and the various sections of track, trolley poles, and connections are now made of standard sizes in stock, thus enabling roads of this sort to be constructed rapidly and economically.

The overhead cableway, for handling hay, wood, and other materials, finds many useful applications on the farm in connection with electric power, and the combination of the cableway and hay grapple enables large quantities of hay to be stacked by power very rapidly and effectively.

Electricity has also many possible applications on the farm for general power pur-

poses, and numerous examples are given of the driving and threshing machines, hay cutters and presses, pumps, sheep-shearing machines, and other varieties of farm machinery. The use of electric lighting in agricultural work, apart from the replacement of the ordinary lights now employed, is limited mainly to emergency-illumination out of doors, arc lamps being suspended from poles, and supplied with current by means of portable cables, much as in contractors' work.

The general advantages of electric power in agricultural work are being perceived more rapidly in Germany than elsewhere in Europe, although in France M. Felix Prat has labored with much energy and success in this field. Some apprehensions are felt as to the possible opposition of ignorant farm-hands to the introduction of machinery which will supersede hand labour in many ways, but it is hoped that difficulties from this source will be overcome, as they have already been in the case of other agricultural labour-saving machinery.

Central Condensers.

THE advantages of condensation of steam are well-known, but, in many cases the gain does not warrant the introduction of the additional mechanism, and to have an independent condenser for every steam pump or small engine would be as undesirable as to have a separate boiler for each.

The whole principle of the use of steam is that of difference of pressure, which involves difference in temperature, and since many engines are supplied from one battery of boilers it is only reasonable that in large plants it should be though advisable to install one central condensing plant, into which all the steam cylinders should exhaust. In such an arrangement the boilers constitute a reservoir of positive pressure and the condenser one of negative pressure, the difference between them being that utilized by the engine.

In many cases the possibility of using such condensing apparatus depends upon the available supply of water, and hence the problem is complicated with that of providing an ample supply of cold water, or of the use of some method of cooling the same body of water for repeated use.

Various installations of central condensing plants have been made in Germany during the past twenty years, and the popularity of this method has greatly increased of late, and in a paper by Herr Chr. Eberle, in *Stahl und Eisen*, a general discussion of the theory and practice of the system is given, with numerous examples of the special forms made by German constructors.

The theory of such condensers does not differ in principle from that of ordinary constructions, but it is desirable to have the relations stated in the form of equations in order that the effects of various temperatures of condensing and discharge water upon the vacuum may be noted. When the supply of condensing water is limited, and artificial cooling devices are used it is desirable to limit the quantity of water to the least amount consistent with a satisfactory vacuum, and these points may be computed beforehand within practical limits, so that the proper proportions of the apparatus may be determined.

As in the case of smaller apparatus the central condenser may be either of the injection or the surface type. Some of the earlier forms were made as injection condensers, the water being delivered into direct contact with the exhaust steam, one of the most effective designs being arranged with a series of drip pans, placed one above the other, the water flowing downward from one pan to the next in thin sheets, the current of steam moving in the opposite direction to the water, the whole being placed high enough for the discharge water to flow out by gravity, leaving only the entrained air to be removed by pumping.

In general, however, it is preferable to use surface condensers rather than to have the condensing water mingle with the condensed steam, as a surface condenser delivers water for the boiler-feed free from any soluble salts which would form scale. The formation of scale, however, which is thus prevented in the boiler, may be transferred to the condenser under certain conditions, and Herr Eberle devotes a portion of his paper to the action in such condensers of waters containing salts in solution. The carbonates of lime and magnesia are deposited whenever the temperature of the

water is raised sufficiently high to drive off any of the carbonic acid, and even before this temperature is reached the solution is diminished, so that more or less precipitation occurs.

If, however, the temperature of the discharge water is not permitted to rise above 50 degrees to 60 degrees C. (122 degrees to 140 degrees F.) no inconvenience from this source will occur, while sulphates require a still higher temperature for precipitation.

When plenty of condensing water is available a surface condenser for a central plant does not differ materially from the independent condensers made for marine service, the water flowing through tubes passing through a closed vessel into which the steam is discharged and in which the vacuum is maintained; an air pump being used to remove the accumulated air and water. Sometimes modifications are made, such as passing the steam through the tubes, or special forms with flat condensing surfaces are employed.

When, as is frequently the case, the supply of condensing water is limited, some form of cooling apparatus must be used, and it is to the development of this form that mechanical ingenuity has of late been directed. The earliest plan, one which has been used for many years both in England and America, is that of a shallow pond, into which the hot water is delivered, and in which it is compelled to traverse a circuitous path from one end to the other, the contact with the air cooling it sufficiently to permit its use again in the condenser. In some of the later German cooling ponds shown by Herr Eberle, the hot water is discharged as a spray from numerous nozzles, thus being brought into intimate contact with the air, and rapidly parting with its heat.

The latest forms of surface condensers are those of the evaporative type, in which the steam passes through nests of tubes upon which water drips, the whole being inclosed in a chamber through which a powerful circulation of air is produced by a fan blower.

The evaporation of the water from the surface of the tubes abstracts the heat very rapidly, and the formation of steam within is practically effected by the formation of steam without, so that a very small

quantity of water is required, clouds of vapor being driven off with the air discharge, and only the excess dripping to the tank below. Although this system requires a constant expenditure of water the quantity is so much less than is needed for contact condensation, that these evaporative condensers are finding wide application in all parts of Germany.

The installation of a central condensing plant effects much greater economy than that due merely to the vacuum attained in the main driving engines, since all the minor steam engines, pumps, etc., deliver their exhaust steam into the common exhaust main, and as these auxiliary machines are among the most wasteful of steam the application of a vacuum to their cylinders enables them to be operated with a proportionally greater economy than is the case with better designed engines.

Herr Eberle's paper contains many illustrations of the condensers of the best German makers and is well worthy of examination by power plant engineers.

The Progress of the Siberian Railway.

IN view of the important international significance of some of the modifications in the route of the Trans-Siberian railway, the progress of the work is attracting renewed interest, and, in a recent issue of *Le Génie Civil* M. de Batz gives a general review of the present state of the undertaking, in connection with the railway work in eastern China.

The change by which the original route along the valley of the Amoor was replaced by the line through Manchuria has already been fully discussed in these columns, but, when the modification was first made public, it was stated to have been selected entirely for constructive reasons, the terminus on the Pacific coast still being Vladivostock.

It is now apparent, however, that the true terminus is to be Port Arthur, and, while Vladivostock will also be reached, there is little doubt that political reasons, as well as engineering features, had much to do with the choice of the route through Chinese territory.

The railway was at its origin undoubtedly a military project, and, as Vladivostock

was the base of action of the Russian fleet in the Pacific, and the location of an important arsenal, it was naturally the only terminus considered. After the events of the war between China and Japan, and the entrance of Russia into the settlement of the questions which followed, the desirability of shortening the route of the railway was made a pretext for the negotiations between Russia and China for the right of way through Chinese territory, and this was followed by the financial arrangements with the Russo-Chinese Bank and the entire revision of the scheme of the Trans-Baikalien portion of the railway.

A glance at the map of the revised route shows that, as the coast is approached, it is necessary to turn toward the north to reach Vladivostock, while at about the same distance on the south lies Port Arthur, possessing numerous advantages, and free from ice throughout the entire year. These reasons appear to be of sufficient importance to warrant the selection of the terminus and harbour, which is not in Russian territory, but which is undoubtedly within the so-called "sphere of Russian influence."

The importance of realizing the advantages to be gained from these recent concessions has caused work upon the Manchurian end of the railway to be pushed forward with all speed, and M. de Batz gives data showing the energy which has been put into the various sections of the road since the details of the route have been finally settled.

The Siberian railway properly begins at Tcheliabinsk, at the boundary between Europe and Asia, in the Urals, and the western section, of 860 miles in length, reaching to the Obi, is completed and in operation. The central section comprises that portion between the Obi and Irkoutsk, and consists of two divisions. The first of these, from the Obi to the Yenesei, 470 miles, is completed, but the second portion, including the great bridge over the Yenesei,—one of the most important engineering features of the road,—has progressed more slowly, though it is expected to be finished early in the present year. A large part of the permanent way on this portion is finished, and in operation; but, until the bridges are finished, the passen-

gers and merchandise must be transported by ferries. There is no doubt, however, that before the middle of 1899 all the bridge work will be completed, and also the short line from Irkoutsk and Lake Baikal, and that there will then be a through railway line from the Urals to Lake Baikal—a distance of 2,000 miles—in active operation.

It is at Lake Baikal that the Manchurian section of the road begins, the official name of this portion being the Eastern Railway of China, and it is on this portion that efforts are now to be concentrated.

M. de Batz gives some interesting accounts of his experiences during a journey over the road from Tcheliabinsk to Lake Baikal, and, as a number of the connecting links between the various sections were at that time uncompleted, the journey included some tedious connections by ferry and wagon, which are now replaced by railways.

A number of illustrations accompanying the article referred to give an excellent idea of the substantial character of the station buildings at various points along the completed portion of the road, and a map shows the status of the work on the new part, together with the important connections to be made with existing railways. The proposed extension to Port Arthur will connect directly with the partially-constructed road from Newchwang to Peking, and, unless diplomacy interferes to modify this portion of the plan, the communication between the capitals of Russia and China will be uninterrupted, and over no territory other than that of the two nations directly interested.

Compression in Steam Cylinders.

It is no more than a year since Professor Dwelshauvers-Dery announced, as the result of the investigations with his experimental engine at Liège, that compression in a steam cylinder is essentially a wasteful operation, and that it cannot be considered at all as a satisfactory means of overcoming the injurious effect of clearance.

Such a contradiction of the hitherto-accepted dictum of Zeuner, and so apparent a disregard for what had been supposed to be the teaching of experience, naturally attracted much attention and no little comment; and Professor Dery's original paper,

which appeared in the *Revue de Mécanique*, received some severe criticism, notably from the pen of Professor Boulvin, of the University of Ghent. In consequence, the whole subject of clearance and compression has received a thorough overhauling in many quarters.

In a recent issue of the *Revue de Mécanique* Professor Dery contributes a paper upon the practical theory of the steam engine, and there is also a paper upon the subject of clearance and compression, by Professor Anspach, of the University of Brussels, both papers containing interesting matter upon this much-discussed subject.

The article of Professor Dery is devoted mainly to an elementary discussion of Hirn's analysis of the action of steam in a cylinder, which, he affirms, is based upon the two fundamental principles of the indestructibility of matter and of energy. Two complete cycles of action are then examined, one relating to the working fluid and the other to the containing metal, and the corresponding equations for the successive periods are deduced.

Some interesting points are given as to the precautions and methods to be observed in the conduct of a test, in order that reliable data for use in connection with Hirn's analysis may be obtained, after which the data of the experiments at Liège are given and the analysis applied.

As the tests undoubtedly indicate a definite loss, increasing with the degree of compression, some means of accounting for the fact must be found, if the loss is not to be attributed to the compression. If it is due to the presence of moisture in the cylinder at the termination of the exhaust, as has been suggested by the experiments of Mr. Bryan Donkin, there appears to be a defect in the analysis of Hirn, but, otherwise, Professor Dery asserts that his position as to the wastefulness of compression is fully sustained.

The paper of Professor Anspach is mainly a review of the discussion between Professors Dery and Boulvin, and, while the accuracy of the Liège experiments and the truth of the losses with increasing compression are not questioned, yet doubt is expressed as to the competence of the present theory to explain the phenomena, and

especially as to the wisdom of depending closely upon conclusions drawn from minute changes in the form of indicator diagrams. Rather is the true theory of the action of steam in a cylinder yet to be enunciated, and, not until after many laborious experiments made with care and skill equal to those exercised by Professor Dery, can we expect to possess a sufficient mass of data to enable us to arrive at the laws governing this complex subject.

The Electric Motor in the Machine Shop.

It is now generally admitted that electricity is the coming method for the distribution of power to the various tools in machine works, and in many instances it has already arrived.

As might be expected, the earliest users of motors for individual tools were the manufacturers of electrical machinery, and in a number of the establishments where dynamos, motors, and other electrical machinery are made, belting and shafting have been abandoned to a great extent, and electric driving substituted. This is notably the case in the works of the *Allgemeine Elektrizitäts-Gesellschaft* at Berlin and in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure* an excellent account is given of the arrangement of the machinery in this important establishment.

The older part of these works was arranged for belt driving, and in some portions the old system still remains, but as the capacity was increased and new buildings added, electric driving was installed and thus excellent opportunity given for comparison of the two systems.

Among the first machines to be operated by electric motors were the travelling cranes and other hoisting machines, their especial adaptability for this purpose being apparent from the ease with which the electrical connections permitted power to be delivered to the moving bridges.

Some pumps, situated in inconvenient locations for power transmission, were the next application, and as new special tools were added electric driving was in nearly every case applied, either by the use of separate motors, or in the case of smaller machines, by "group" driving, sections of shafting being operated by motors, and

belt driving being employed only from the motor-driven shaft to the tools.

As is usually the case, a growing establishment cannot be planned out entirely beforehand, and one of the greatest causes of waste in power transmission is the effort to get the power around corner, and across inconvenient spaces. With electric transmission such difficulties disappear, and for like reason the time-honored system of arranging the position of tools in the shop with regard to the direction of the line shafting, instead of convenience of handling material, no longer appears. Lathes may be placed in rows across the room, small machines may be put anywhere, as may be most convenient, and operative considerations generally permitted to govern the location of tools, since the power can be transmitted anywhere with perfect ease.

Some views of the interior of the old and new parts of the works are most convincing object lessons of the great advantage of electric driving of machine tools by independent motors; and the contrast between the wilderness of overhead belts, pulleys, and shafting, with the light, clear space above the machines in the new portion, speak louder than any words as to the advantages of electric driving.

There can be no doubt whatever, that the machine shop of the immediate future will have electric motors used for all tool driving, and that belting will be used only in a few special cases. Machines will be placed where they can be most conveniently driven, the location of building will no longer be decided by considerations of power transmission, and one of the greatest causes of the waste of power will be almost entirely eliminated.

The Progress of the Diesel Motor.

SINCE the rather dramatic announcement of the invention and successful operation of the so-called "rational" heat-motor by Herr Rudolf Diesel at the Cassel meeting of the Society of German Engineers in 1897, material progress has been made in placing the new motor before the public. A number of firms in Europe have undertaken the construction of the motor, and arrangements have been made for its manufacture in the United States, tests by Pro-

fessor J. E. Denton having shown results confirming the high economy obtained in Germany.

A paper by Herr Dieselin the *Zeitschrift des Vereines deutscher Ingenieure* gives some of the more recent designs of the motor which have been made in Germany, and also discusses some of the experiences which have been obtained with the use of various fuels.

Several Diesel motors were shown at the recent exhibition in Munich, four of the leading machine works of Germany being represented; although the general principles were alike in all, there existed minor differences in construction, some of which are of interest.

The fundamental points of the Diesel motor have been described frequently, and may be summed briefly, as follows:

In a single-acting cylinder, air is permitted to enter on the first outstroke, and on the return stroke is compressed to a pressure of about thirty-five atmospheres. During the second out-stroke petroleum is injected into the cylinder, and, igniting from the heat produced by the compression of the air, burns, producing the energy which forces the piston out. The air which enters the cylinder is previously compressed in a separate pump, the final compression alone being given in the power cylinder. There is, therefore, but one power stroke in every four, the momentum of the fly-wheel being used to carry the motion through the remaining portion of the cycle. Tests of this motor have shown a thermal efficiency of about 38 per cent., while that of the best steam engines barely attains 15 per cent., and that of the best gas engines about 25 per cent.

The reasons for the attainment of this high economy are several. In his original presentation of the motor Herr Diesel showed that the highest degree of efficiency ought to be had by the realization of the Carnot cycle, using adiabatic compression and isothermal combustion; within practical limits, these conditions are fairly well attained in the motor. In addition to the use of an efficient cycle, however, the economy is enhanced in no small degree by the completeness of the combustion.

In the previous forms of gas or petroleum engines the fuel is admitted to the

cylinder at the same time as the air, and efforts are made to obtain such a mixture as will produce the best combustion; but the correctness of the mixture is often difficult of control, and consequently the combustion is frequently very imperfect. This is especially the case when, as in most gas engines, the regulation is effected by the hit-or-miss method, in which case there is often an excess of combustible after an explosion has been missed. The certainty of ignition and the completeness of combustion can by no means be assured, either with the hot-tube or the electric spark, and it is generally admitted that in most gas engines much of the waste is due to imperfect combustion.

If these conditions are true with the internal-combustion motor, how much more difficult is it to secure perfect combustion in a boiler furnace! A complete admixture of air with the fuel is practically impossible, and the entrance of cold air, and the proximity of comparatively cool boiler surfaces, are fatal to anything like a thorough combustion of the fuel, so that it is hopeless to expect any great advance in economy in this direction.

In the Diesel motor, however, the conditions are entirely different. The air in which the combustion is to be effected is compressed before any of the fuel comes in contact with it, and is also raised by this compression to a temperature far exceeding that of the ignition of the fuel. The petroleum is then injected into a space containing an excess of air above that needed for combustion, at a temperature above that required for a complete combination, the combustion being also assisted to a great extent by the compression.

Under these conditions it is found that the combustion in the cylinder of the motor is practically perfect, and there is no smoke given off with the discharge gases, nor is there any deposit of unburned carbon in the cylinder, even after prolonged periods of continuous operation.

The motor has been operated with a variety of liquid fuels, benzines, illuminating petroleum, fuel oils, such as "Eagle," Lima, and California crude oils, and the very thick naphtha residue from the Russian oil fields, known as "Masut," the latter having a specific gravity of 0.905. So far as

the combustion is concerned, the character of the fuel appears to have no effect, there being no residue in any case, the heavy oil burning as completely as the light benzine, so that a material portion of the efficiency of the machine must be attributed to the perfection of the combustion. Experiments have also been made in Germany with the so-called "spiritus," a methylated alcohol containing from 10 to 15 per cent. of moisture, the results being equally satisfactory.

One of the latest forms of the motor, described by Diesel in the paper referred to, is a double engine, there being two cylinders side by side, with coincident cranks, but with the valve gear so timed as to cause the power strokes to alternate. This arrangement, similar to one which has already been used for gas engines, conduces to greater steadiness of motion by equalizing the action upon the crank shaft.

The Disinfection of Cattle-Cars.

THE determined efforts which have been made in various parts of Europe to prevent the spread of disease among cattle have led to the consideration of the best methods of preventing the contagion which may occur through the railway shipment of sound animals in cars which have contained diseased cattle on previous occasions.

A paper upon this subject by Herr Adoli Freund, in the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines*, gives an excellent account of the various methods of disinfection practised in Austria and Germany, and the subject is one which demands the careful attention of railway managers.

Accepting the bacterial origin of the diseases which are to be combated, it follows that any efficient method of disinfection must act to kill the pathogenic bacteria which may be in the car. It should be the invariable rule, however, that regardless of the use of any special disinfection, general cleanliness must be maintained, the cars being thoroughly washed out between trips with hot water. In many instances this is all that is necessary, unless there has been reason to suspect that infected animals have been transported. It is, however, so difficult to be assured of the healthy character of all the animals carried that the safest plan is to have some effective method

of sterilizing the cars for regular use at all times, with a reserve of powerful disinfectants for times of epidemic.

In addition to the regular washing, the methods used on the continent for disinfecting cattle cars are as follows:

Steam at atmospheric, or slightly higher, pressure is used in Austro-Hungary, Switzerland, and Russia; in the Netherlands higher pressures, up to six atmospheres (corresponding to 160° C.), are employed, sometimes alternating with chemical disinfectants.

In Belgium steam is used in connection with atomizing devices for the purpose of pulverizing liquid disinfectants. Hot alkaline solutions are extensively used, sometimes in connection with the regular washing, and chloride and sulphate of zinc are also used, the latter especially in France. Chloride of lime is a favorite disinfectant, and, in cases of epidemic, carbolic acid and bichloride of mercury are applied, the latter only in Italy and in the Netherlands.

In practice the use of steam appears to give excellent results, especially when the pressure is such as to insure a temperature high enough to destroy the germs. The experiments of Koch, Gaffky, and Löffler have demonstrated that, even with steam at atmospheric pressure, and hence only boiling temperature, all disease germs are destroyed in five minutes. A simple arrangement of piping will enable the steam to be introduced from the boiler of any convenient locomotive,—one of the advantages of steam over any chemical treatment. An excellent method of steaming the interior of a car, when heat is available but no steam can be had otherwise, is to heat a plate of metal to a high temperature, place it in the car, and pour water upon it; the steam given off will serve the purpose.

The use of chemical disinfectants involves several considerations, which must be observed if satisfaction is to be attained.

Most of the usual disinfecting materials, according to Gruber, cannot be depended upon to destroy contagious germs at ordinary temperatures, unless used in very strong solutions. Even a 5-per-cent. solution of carbolic acid has been found unequal to destroying the germs, when used cold, and in any case the persistent odor

is most objectionable, if the cars are to be used for the conveyance of any other kind of merchandise.

The influence of heat in increasing the efficiency of disinfectants has been fully demonstrated, and, in the case of carbolic acid or formaldehyde, it appears to be essential, but experience on the Austrian railways show that a filtered solution of chloride of lime (5 per cent.), when used as a cold spray, can be depended upon to destroy the germs in a very effective manner. If the metal work of the car is protected by a barium paint, any action of the chlorine upon the metal is prevented and the simplicity, safety, and convenience of the method, added to its efficient action, render it, in the opinion of Herr Freund, the best process that can be adopted.

The Melan Bridge at Steyr.

THE importance of the combination of concrete and structural steel for bridge construction is made evident by the increasing use of this method both in Europe and America.

A recent application of the Melan system is seen in the new bridge at Steyr, in Austria, of which a well-illustrated description is given by Professor Melan in a recent issue of the *Zeitschrift des Oesterr Ingenieur und Architekten Vereines*.

The Melan system is especially adapted to flat arches, that at Steyr being of 42 metres' span by only 2.85 metres' rise.

The bridge consists of six lattice arches formed of plates and angles, with hinges at the crown and springings, these arches being completely imbedded in concrete consisting of 1 part of Portland cement, 2 parts of sand, and 4 parts of broken stone. The moulding of the concrete was performed so as to provide for the free movement of the hinges of the metallic arches, while at the same time the concrete surrounds the halves of the arches in such a manner as to form each half of the bridge into a monolith of concrete containing a structural metallic skeleton.

The tests of the bridge, conducted with much care, showed a maximum deflection of only 39 millimetres (1.53 inches) under a full load of 460 kilogrammes per square metre, or about 92 pounds per square foot.

THE AMERICAN PRESS

Review of Leading Articles

By-Product Coke Ovens.

AMONG the papers presented recently before the American Institute of Mining Engineers, are two which give opposite points of view of a very important industry, which, in the United States, at least is hardly up to the status of other branches of metallurgy. One of these papers is an account of the bee hive coke-ovens in the New River District of West Virginia, by Mr. Charles Catlett, while the other is a description of the Semet-Solvay by-product oven plant at Ensley, Alabama, by Mr. W. H. Blauvelt.

By far the greater portion of the coking in the United States is done in ovens of the bee-hive type, notwithstanding the low efficiency of this primitive contrivance and the entire loss of all by-products which their use entails.

From analyses given of the coal used by the New River Coke Company, there should have been only about 3 per cent. of ash, and the theoretical product of coke should be about 75 per cent. As a matter of fact, the majority of the ovens in the district do not yield 60 per cent., and observations indicate that many of them run less than 55 per cent. This appears to be much lower than should be obtained, and indicates that, in addition to the volatile matter, about one-fifth of the coke is burnt up in order to secure the other four-fifths. This poor economy is attributed by Mr. Catlett to an excessive amount of air, but even with the best of air regulation, the inherent defects of the old type of oven are such as to render the best efficiency impossible.

The by-product coke ovens described by Mr. Blauvelt represent a far higher grade of practice, and show that even in so simple a process as that of coking coal there is room for much ingenuity in design and in operation.

In the Semet-Solvay oven the coking is performed in retorts, or rather chambers, which are filled with coal and tightly sealed, the heating being effected by means of flues

in which gas is burned between the chambers. This gas is a portion of what is driven off from the coal, and by its combustion with hot air a high temperature is readily maintained in the flues. The heat passes through the thin walls of the flues into the coal, which undergoes a true distillation, the volatile matter passing off without coming in contact with any air; consequently no combustion takes place. There is, however, a little breaking down of the hydrocarbons by the action of the heat, and a deposition of carbon that causes the retort-oven to yield a higher percentage of coke than the theoretical, while the beehive oven yields less than the theoretical, owing to the partial combustion of the fixed carbon that takes place.

In the by-product oven the gases delivered from the retorts are delivered to a collecting main, and by being allowed to bubble through water a portion of the tar and ammonia are condensed and saved. A second portion of tar and ammonia is removed by the use of tubular condensers, and the last traces abstracted by a scrubbing apparatus, after which the cooled and purified gas is used for burning in the flues.

In this way from 15 to 25 pounds of sulphate of ammonia and 5 to 14 gallons of tar are obtained from a ton of coal, and from 8,000 to 11,000 cubic feet of gas. Only 5,000 to 6,000 cubic feet of gas are required to heat the ovens, and the waste heat is also available for the necessary steam-making purposes, and the remainder of the gas is available for any purposes which may require it. In the case of the coke ovens at Ensley, the surplus gas, which amounts to some two million cubic feet per day, is to be used in the steel mill for soaking pits, drying ladles, and as an auxiliary to producer gas in connection with the open hearth furnaces; and being of a better quality than producer gas, will be found most useful. It might also be made available for the direct production of power in gas engines, although apparently this application has not yet been attempted.

The comparison of these two coke-making plant affords a contrast well worthy of consideration. On the one hand a primitive and wasteful method, yielding little more than one-half of the theoretical quantity of the main product, and wasting all the marketable by-products, and on the other hand, a plant giving fully 100 per cent. efficiency in coke, besides yielding valuable commercial by-products, together with heat and power far above what is required for the demands of the plant itself.

Dr. Johnson once defined a weed as a plant, of which the use had not yet been discovered; perhaps we might equally well define a by-product as something valuable which most people willingly permit to run to waste, and in these days of close competition the difference between waste and economy frequently means all the difference between commercial failure and success.

Wooden and Masonry Dry Docks.

IN view of the present urgent need of additional docking facilities for the United States Navy, and the general desire for a higher grade of construction than that which has heretofore been employed in this work, a discussion of the relative merits of masonry and timber dry docks was recently held before the American Society of Civil Engineers, and some important and useful information elicited.

In the discussion, which was opened by Professor William L. Cathcart and Commodore Mordecai T. Endicott, U. S. N., the only advantage which could be indicated for the timber construction was that of lower first cost, but doubtless few of those who have advocated the building of wooden docks as a measure of economy have realized the greatly increased cost of maintenance of timber over masonry, as shown by Professor Cathcart.

Thus in the case of the stone dry docks at Boston and at Norfolk, Va., 31 years in the first case, and 15 years in the second, the average costs for maintenance have been \$2,000 and \$1,251 per year; and at Brooklyn, where the conditions as to foundation have been very unsatisfactory, the maintenance cost averaged \$4,680 per year.

The timber dry docks at the various navy yards make a very different showing. The

apparent cost for maintenance, taking into account only the charges for current repair work, is very low in every case, but, unlike the masonry docks, the maintenance is of a kind which cannot maintain the dock in continual good order, the structure deteriorating from the very start. In all cases the decay, yielding and general deterioration have made large appropriations for reconstruction necessary, and charging this work to maintenance, where it properly belongs, it is demonstrated that one of the timber docks at New York has cost over \$30,000 per year for maintenance, and the other one more than \$85,000!

According to Commodore Endicott a timber dry dock must practically be rebuilt in from 20 to 25 years, and the experience of the navy shows that the expenditures required to keep them in condition aggregate finally several times as much as those for masonry docks, while the repairs to the latter are very small indeed.

The greatest danger to a dry dock is the upward pressure in the soil beneath the level of high tide, acting from without, and this can of course best be resisted by a masonry dock. The only way in which the stability of a timber dock can be preserved is to let the water in and pump it out, and in many cases serious injury has resulted to timber docks, particularly about the entrances, from this cause.

"The British government owns or controls 62 graving docks. Only one of these is of timber, namely, at St. John's, Newfoundland, which was built by the Newfoundland government. France has 36 graving docks, all of masonry; Germany has 11, all of masonry. A large dock recently designed for a private corporation, to be subsidized by the German government, was to have been built of timber, but the government refused to give the subsidy unless it should be built of masonry. Italy has 12 graving docks, all of masonry."

In view of the overwhelming preponderance of testimony as to the advantages of masonry docks, both as to safety and economy, when maintenance is taken into account, it seems as if the construction of any wooden docks by the United States government can hardly be considered as a possibility, and if such action is taken it will be in the face of the best expert opinion and

Heavy Rail Sections.

THE great increase of railway speeds, together with the increase in the weight of engines and trains, all of which has occurred in comparatively few years, has only been made possible by the employment of far heavier rail sections than would formerly have been considered possible or desirable, and in a paper before the recent meeting of the American Institute of Mining Engineers, Dr. P. H. Dudley reviews the important results which have been obtained by the use of stiff and heavy rail sections during the past fifteen years.

Express trains of 8 to 12 passenger coaches, drawn by locomotives weighing 100 to 110 tons, are regularly sent out to make schedule speeds between terminals of 45 miles per hour, involving intermediate speeds of 50 to 60 miles, while freight trains of 50 to 75 cars of 60,000 pounds capacity are drawn by one locomotive. Solid mail trains of 6 to 8 cars are run from New York to Chicago, 1,000 miles, in twenty-four hours; and shorter trains are running from Chicago to San Francisco, 2,000 miles, in three and one-half days.

Within the past fifteen years freight cars of 20,000 pounds capacity and about the same dead weight, have been replaced by cars of 60,000 pounds capacity and a dead weight of only about 45 per cent. of the capacity, while a number of 80,000 pound cars have been constructed, and are in service, and some of 100,000 pounds capacity have been made.

These are some of the results which have been made practicable by the use of heavy and stiff rail sections in the past, and there appears to be no prospect that the end has been reached. On the contrary, both the static wheel loads and the speed of trains are increasing, and the severer requirements of service must be met largely by applying principles now well known to prevent the generation of large destructive dynamic forces under the moving trains and by raising to a higher efficiency, in an economical way, everything which appertains to transportation.

The advantages attained with stiff and heavy rails are due, not only to the reduction in dynamic effects, but also to the distribution of the load over larger areas of the road bed, so that the heavier static

loads with the lessening dynamic loads are not so destructive to the ties and the road bed as was the case with the lighter static and dynamic loads on the weak rails formerly employed. This is conclusively proved by the fact that a higher standard of track is maintained with the heavy rails, notwithstanding the greater volume of traffic.

Mr. Dudley gives numerous examples of the effects of the gradual advance since the laying of his pioneer 5-inch 80-pound rail, in 1894, showing the considerations which governed the distribution of the metal, and the successful efforts to obtain a steel which should be tough, quite hard, and yet not brittle, and shows how the manufacturers have kept pace with the demands upon them.

No mathematical analysis has been able to satisfy the complex conditions of stress which exist in rails in service, and the actual magnitude and distribution of the stresses can only be determined experimentally in the track by the use of some such apparatus as the stremmatograph, used with such success by Dr. Dudley.

An important point in this connection is the fact that the short duration of the stresses permits them to be much larger than would be permissible in bridges and similar structures. In many cases it has been clearly shown that with the former light rail sections stresses exceeding the elastic limit occurred, a marked set being observed.

Dr. Dudley's paper contains much that is of interest to the railroad man as well as the manufacturer, and in view of the results which have been attained in the past there is every reason to believe that the remaining problems in rail design and construction will be solved in close accordance with the actual conditions of service.

The Inter-Continental Railroad.

THE publication of the handsome and very complete report of the several survey parties which have been at work on various parts of the proposed route to connect the railways of North and South America is the culmination of an undertaking which has been before the public for the past nine years.

The report consists of four large volumes

and three cases of maps, the volumes containing numerous illustrations, from photographs, and being printed in both English and Spanish, while many of the maps are very handsomely executed.

The object of the survey was to ascertain the practicability and probable cost of a railway to connect the systems of the United States and Mexico with those of South America, and the work was conducted by three parties, composed of military and civilian engineers, 85 per cent. of the total cost of \$288,586 being borne by the United States Government, and the balance by Brazil, Equador, Bolivia, and the Central American States.

The work done by these parties was naturally very unequal, but it all shows care, energy, determination and good judgment in overcoming unforeseen obstacles, and portions of the volumes form most interesting reading, apart from their value as records of engineering work. The first party, under Lieutenant M. M. Macomb, U. S. A., was well equipped with instruments for field astronomy, and also carried mercurial and aneroid barometers for altitude determinations. Much of the territory covered by this party was included in a rough triangulation, the principal points being checked by astronomical determinations, and all three parties united in completing a preliminary railroad survey, using transit, stadia measurements, odometer, and barometers.

The result is a fairly reliable survey showing the probable route to be followed for the construction of the railway necessary to complete an all-rail route between New York and Buenos Ayres, the distance between the two cities being 10,228 miles, of which 4,772 miles are now in existence, and 5,456 miles remain to be built. It is estimated that the cost of building the remaining portion of the line will be \$175,000,000, and that there are no serious physical obstacles to its construction.

As to the commercial side of the question the report is silent, and indeed it was not upon this portion of the subject that it was expected to speak, excepting as to the estimated cost of the work. The commerce between the two Americas is not at present so great but that the cheaper water communication is amply capable of providing for it, but we have all heard that "facilities

create traffic," and such a road would naturally have to depend to a great extent upon the local traffic to justify its existence. It must not be forgotten that all the early arguments for a railway to the Pacific were based upon the supposed demand for communication with the Far East, a consumption which now appears to be approaching, but for which the Pacific railroads might have waited long for revenue. The Inter-Continental Railway may not, probably will not be built for many years, but these difficult surveys, well recorded in this excellent report, may some day bear much the same relation to a great completed work as does the well-known series of volumes of Pacific railway surveys to the many lines which now cross the North American continent.

Improvements in Boiler Material.

THE demand for high steam pressures, especially in marine practice, has worked a revolution in boiler design and construction, and as a natural consequence, there has arisen a demand for boiler material of quite a different grade and character from that formerly acceptable.

The recent advances in the manufacture of high-grade boiler and pipe material form the subject of an important paper in the *Journal of the American Society of Naval Engineers*, and some of especial requirements of the Bureau of Steam Engineering of the United States Navy are there given in detail.

The cumbrous Scotch boiler is now distinctly regarded as old style, and the lighter water-tube boiler, with its practically limitless possibilities in the way of providing steam at any desired pressure and within the shortest possible time, comes in with an initial jump of 100 pounds per square inch over the upper limit of recent custom. It does not appear, however, to be half as much of an innovation to design boilers for pressures of 250 pounds, with a reduction to 200 pounds at the engines, as it did twenty years ago to use steam at 100 pounds with the introduction of compound engines, prior to which working pressures rarely passed the 50 pound mark.

Of late years, and indeed, ever since mild steel set out to replace wrought iron, there has been continuous and rapid progress in

the art of manufacturing this material, until any desired quality can be uniformly produced by the most careful makers. The thorough inspection and severe tests which have been imposed by the Bureau of Steam Engineering have assisted very materially in the advances which have been made in the art of steel making in the United States, with a result of almost entirely eliminating the elements of unreliability and non-uniformity.

Much attention has been directed to the advantages of nickel-steel for bracing and rivets, and in the case of nickel-steel rivets with a tensile strength of more than 75,000 pounds and an elastic limit of 40,000 pounds, a much smaller rivet may be used than formerly, thus requiring the cutting away of much less of the original plate for holes. The especial adaptability of nickel-steel for braces and rods is also clearly shown, and the toughness and uniformity shown by the test specimens are remarkable.

An interesting comparison of the practice of the Bureau of Steam Engineering in the requirements for boiler materials is given by the publication of the specifications for the boilers of the Maine, built in 1888, and those issued in 1898 for the torpedo-boats, monitors, and battle ships now under construction.

Thus, ten years ago, the requirements for shell plates were: tensile strength between 58,000 and 67,000 pounds, with an elongation of 22 per cent., and an elastic limit of 32,000 pounds. The corresponding requirements of to-day are: tensile strength, between 74,000 and 82,000 pounds, elongation 21 per cent., elastic limit 40,000 pounds. In 1888, rivets and stay rods were required to have a tensile strength of 50,000 to 58,000 pounds, and in 1898, of 75,000 to 85,000 pounds, and the other requirements show a corresponding advance.

Boiler tubes, fittings, and steam and water pipes are now subjected to greatly increased pressures and require correspondingly increased care and attention. Steel is generally used as the material and lap-welded steel pipe is made of such quality that sharp angle flanges can be turned and opened cold without developing any cracks or flaws. Seamless-drawn pipe is now also used to great advantage, and solid flanges

are welded to these pipes with perfect success, or still more recently, the end of the pipe has been upset and then by spinning the end over under hydraulic pressure, a flange can be made wholly in one piece with the pipe. Wrought steel fittings are recent additions to the resources of the engineer in making high-pressure steam connections, and the advantages which they possess over the bulkier and less reliable castings are obvious. The importance of the development of boiler and pipe material of the highest grade will be appreciated when it is realized that it is from increased steam pressures that much of the hoped-for progress in steam engineering must come. Higher pressures mean greater expansion, greater power in smaller compass, greater economy and greater reserve power in time of emergency; and in marine practice especially it is for the great emergency that everything must be designed. It is from the boiler that the power must come, and into the boiler should be put the very best material the skill of man can produce.

Water Filtration at Pittsburgh.

THE general interest which is taken in the subject of the purification of drinking water, and the decided tendency toward the use of sand filtration as a means of removing injurious impurities, renders every record of actual practice important. The presentation, therefore, of the report of the filtration commission of the city of Pittsburgh, Pa., after the installation and operation of a modern filtration plant, is especially worthy of record, and from the account given in the *Engineering Record* we make a general abstract.

The city of Pittsburgh is supplied by the Allegheny and the Monongahela rivers, both of which stream receive the drainage of numerous towns, and are therefore polluted to an extent and manner altogether beyond the control of the Pittsburgh authorities. The water of these rivers is also very turbid, even under ordinary conditions, while after heavy rains the amount of suspended mud is particularly objectionable.

It was this presence of mud which caused the city councils to hesitate about introducing sand filtration, since sand filters, although well-known to be the most efficient

means of removing bacteria, had in no case been used to filter water so muddy as that from the Allegheny river. Mechanical filtration, which is successful in removing mud, is not considered so effective with regard to bacteria, and hence it was thought advisable to make comparative trials before installing the entire plant. Experiments were therefore made with one sedimentation basin, two sand filters, and three forms of mechanical filters.

The sand filters were about 25 by 13 feet, and were run at a rate varying from two to five million gallons per day, the rate appearing to have no influence upon the bacterial efficiency. Whenever the loss of head due to the resistance of the filter reached four feet, the filters were scraped, and then filled with filtered water from below. The efficiency of these filters was excellent, reaching 99.21 per cent. in one case, and 98.92 per cent. for the other, during a period of 13 months. The average number of bacteria in the raw water was 16,340, and the average number in the effluents in the beds was 129 and 177.

In order to examine the effect of turbidity, one filter was used with raw water, and the other with water from the settling basin, and when the water was very turbid it was found that the filter soon became clogged and showed a marked reduction in bacterial efficiency, although the settling alone removed very few of the bacteria. Settling basins may therefore be considered as essential when the water is very turbid. No trouble appeared from the presence of crude petroleum or mine drainage on the water.

The mechanical filters were also given careful tests, and under certain conditions gave excellent results, but it was found that the use of a coagulant, such as sulphate of alumina was necessary, in order to insure the removal of the bacteria, and when the coagulant was omitted the number of bacteria in the effluent increased rapidly. The mechanical filters produced the clearest water, but the bacterial efficiency of the sand filters was found to be the best, while the possible pollution of the water by failure to use the coagulant even for a short time, is a decided objection to the mechanical filters, so far as public health is concerned.

The report of Professor Sedgwick showed clearly that the polluted water was the principal source of the constant and excessive amount of typhoid fever in Pittsburgh, and the report of Mr. Allen Hazen upon the best method of purification, was in favor of sand filters with sedimentation basins. For a daily consumption of 75 million gallons per day, such a plant is estimated to cost a little over two million dollars, while it would cost six times as much to bring water by gravity from a pure source.

It is interesting to note that the report comes out strongly in favor of water meters, and in this connection Mr. Hazen says:

"The city is now wasting several times as much water as it uses. The experience of other cities shows that the consumption can be greatly reduced by the adoption of the meter system for the sale of water, and the cost of filtration and pumping kept within reasonable limits."

The close relation which the use of meters bears to filtration is seen in the fact that at the present time only about one-third of the amount pumped, and therefore to be filtered, is really required. With meters the proposed filtering plant will be sufficient for fifteen years; without it the plan will be outgrown before it can be built.

Engineering in Architecture.

IN these days of steel buildings, electric lighting, elevators, steam heating, and innumerable other details of engineering work in building construction, the relations of the engineer to the architect are necessarily very close, and it is most interesting to find those relations very clearly presented to the architectural fraternity in the form of a paper read before the American Institute of Architects, by Mr. H. G. Bradlee.

After referring to the gradual increase of engineering work in connection with building construction, Mr. Bradlee defines the function of the architect as the art of building beautifully, while that of the engineer is that of securing economy of construction and operation. While these two functions are, and always must be, closely related, it is practically impossible that they should both be mastered by one and the

same individual, and even if they were each would be a detriment to the other. Consultation and unity of purpose should undoubtedly exist between both branches, but it is now impossible for the architect himself to be the sole designer of all that goes into the modern building.

"The architect of a modern building, if he is to design it complete in all its details, must therefore be an engineer, and must be familiar with mechanical, electrical, and sanitary engineering in all its branches. Each of these departments of engineering has, however, grown to such an extent that a thorough knowledge of its details can only be acquired by years of study and experience, and what is perhaps more important, they are at present in a state of rapid growth. New methods and new appliances are constantly introduced, so that the best work of ten years ago is considered very inferior to-day."

As engineering work began to creep into architecture it was at first relegated to the contractor, and even to-day many architects expect to receive, and do receive much aid and advice upon matters connected with structural metal work from the engineers of the manufacturers of the material used. Gradually the employment of the consulting engineer has become more common, and the causes which in the past separated the architect from the builder are now at work separating the engineer from the engineering contractor.

At the present time, however, there is no definite practice as regards the employment of the engineer, and Mr. Bradlee suggests that the true relation is to make the engineer the assistant of the architect employed by him, and responsible to him, and not to the owner direct. The engineer is responsible for the design of the building equipment and for the results obtained from its operation, and should be given every opportunity to design the work in the manner which he considers best. The equipment, however, is subordinate to the building itself, and in most cases it is easier to make changes in the engineering work than in the construction of the building. The engineer should therefore be under the direction of the architect, and should be prepared to modify his work to any extent which may be necessary.

Masonry Construction.

NOTWITHSTANDING the great development in the application of structural steel, both for architectural and engineering work, there is undoubtedly a strong revival in favor of genuine masonry construction, and it is interesting to note that a valuable paper upon the use of masonry should have been presented before the Western Society of Engineers by Mr. George S. Morison, who has been identified in such an eminent manner with structural works in metal.

Mr. Morison divides the materials of construction into two classes, the lower and the higher, placing in the former earth and stone, and in the latter, metals and timber. The lower class possesses the great advantage of imperishability, while the higher class has the property of great adaptability. Both are eminently useful, but masonry is the only permanent form of construction available for works of a monumental character, capable of transmitting the work of one epoch to another.

Mr. Morison includes in his paper a brief historical review, showing the intelligent and artistic manner in which ancient constructors made use of masonry, and remarks that much of the old work which is generally assumed to be entirely of stone is really largely of concrete. The Roman builders used brick or stone for facing with a rubble filling which contained such a large proportion of mortar that it was really a concrete, and the excellent character of the mortar caused such structures to be as enduring as if they had been made of solid stone.

Coming down to modern times Mr. Morison shows that even with structures which are largely of iron and steel there are portions for which masonry is especially adapted. It is an absolutely appropriate material for use as a support to carry weight, as in a column or bridge pier, and the same beautiful and satisfactory results as were obtained by the Egyptians and Greeks in architecture are possible to-day in such constructions as the piers of bridges.

Again, for moderate spans, up to 150 or even 200 feet, masonry arches are most appropriate, and in this connection Mr. Morison gives in such clear language the fundamental principles of equilibrium in the arch

that we cannot refrain from quoting them entire:

"A loose cord fastened securely at each end has some form of stability for every loading which can be put upon it, the cord, however, always being in tension. If this curve, which is stable for a particular loading, and no other, is inverted, it is stable for the same loading but is in compression and not in tension; but though the cord in tension, by changing its shape for every change in loading preserves its stability, the inverted catenary would go to pieces with a very slight change in load.

"A masonry arch should act only in compression, and the strains in it are those existing in the inverted catenary. For every form of arch there is some loading that will correspond exactly to its shape. So long as the curve of strain does not pass outside of the middle third of the arch, the arch is perfectly stable and no tension occurs anywhere in the masonry. The masonry of an arch should be so laid that the joints are everywhere normal to the curve of strain, this being the direction in which the pressure acts."

Mr. Morison gives some excellent examples of the influence which proportion has upon beauty in masonry structures, and referring to the fact that art in such work is really the expression of truth in construction, he concludes:

"The construction of such masonry may not be the work of an engineer, but it must be the work of a man educated like an engineer, and who knows how to direct the great powers of nature, if not to the uses and conveniences, at least to the monumental graces of man."

Brick-Making in the United States.

BRICK is probably one of the very oldest materials of construction, but its use has never gone out of fashion, and it is to-day more largely employed than ever. Few people realize the enormous quantity of clay which is dug and worked into bricks in the United States, and for this reason the paper of Mr. C. C. Jones, presented before the recent meeting of the American Institute of Mining Engineers, is of interest, although it deals only with the working of the clay deposits of the lower valley of the Hudson.

Mr. Jones reports upon a careful geologic and economic survey of these clay deposits, the survey including a large number of borings for the determination of the depth of the deposits, the resulting data enabling very complete maps and sections to be made. The report gives some interesting experiences in connection with the conduct of such borings, showing also the care with which they were made.

Four principal localities were included in the survey, showing a total of about 35 million cubic yards of clay available, corresponding to very nearly 30,000 million bricks. Adding to this the probable capacity of other localities in the lower Hudson valley, it is estimated that the present output of more than 900 million bricks per year can be maintained for a period of about 60 years.

This seems like a large supply for at least two generations to come, but Mr. Jones very pertinently asks if we can expect the demand to remain uniform.

"What will be the effect of increased consumption in a rapidly expanding community, now demanding nearly one billion bricks per year, and imperatively requiring a progressively larger supply for fire-proof construction, and taller buildings, with thicker walls, and deeper foundations? What will be the duration of the supply under such demands? Unfortunately, it is not possible to command accurate comparative statistics, even for past periods. The collection of the data of brick manufacture is too recent an enterprise of the United States Geological Survey. A precise numerical forecast is, therefore, impossible at present; but a rough comparison may be made. Aside from an apparent increase in demand of 110 million bricks per annum from 1894 to 1896, and an apparently indicated increase of 25 million per annum in the ten years previous, the one known fact is a present production of practically one billion bricks by the State of New York, which is practically consumed by the city of New York. Economical investigations indicate a supply of practically one billion bricks per year for a period of 60 years. If the demand should rise to double that quantity, the question of supply would acquire an intense practical importance. Who can predict the answer?

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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Each coupon will be received by us in payment for any 20-cent article catalogued in the Index. For articles of a higher price, one of these coupons will be received for each 20 cents: thus, a 40-cent article will require two coupons; a 60-cent article, three coupons; and so on. The use of these coupons is strongly commended to our readers. They not only reduce the cost of articles 25 per cent. (from 20c. to 15c.), but they need only a trial to demonstrate their very great convenience—especially to engineers in foreign countries, or away from libraries and technical club facilities.

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CARD INDEX.—These pages are issued separately from the Magazine, printed on one side of the paper only, and in this form they meet the exact requirements of those who desire to clip the items for card-index purposes. Thus printed they are supplied to regular subscribers of THE ENGINEERING MAGAZINE at 10c. per month, or \$1.00 a year; to non-subscribers, 25c. per month, or \$3.00 a year.

THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, *e. z.* Other abbreviations used in the Index are: Ill—Illustrated; W=Words; Anon=Anonymous.

American Architect. <i>w</i> . Boston, Mass.	Bradstreet's. <i>w</i> . New York.
American Electrician. <i>m</i> . New York.	Brick Builder. <i>m</i> . Boston, Mass.
Am. Engineer and Railroad Journal. <i>m</i> . New York.	British Architect. <i>w</i> . London.
American Gas Light Journal. <i>w</i> . New York.	Builder. <i>w</i> . London.
American Geologist. <i>m</i> . Minneapolis, Minn.	Bulletin Am. Iron and Steel Asso. <i>w</i> . Phila., Pa.
American Journal of Science. <i>m</i> . New Haven Conn.	Bulletin of Bureau of Am. Republics. <i>m</i> . Washington.
American Journal of Sociology. <i>b-m</i> . Chicago, Ill.	Bulletin de la Société d'Encouragement. <i>m</i> . Paris.
American Machinist. <i>w</i> . New York.	Bulletin of Dept. of Labor. <i>b-m</i> . Washington, D. C.
Am. Manufacturer and Iron World. <i>w</i> . Pittsburg, Pa.	Bulletin of the Univ. of Wisconsin, Madison, Wis.
American Shipbuilder. <i>w</i> . New York.	Bull. Int. Railway Congress. <i>m</i> . Brussels.
Am. Soc. of Irrigation Engineers. <i>qr</i> . Denver, Col.	California Architect. <i>m</i> . San Francisco, Cal.
Annals of Am. Acad. of Pol. and Soc. Sci. <i>b-m</i> . Phila.	Canadian Architect. <i>m</i> . Toronto, Ont.
Annales des Ponts et Chaussées. <i>m</i> . Paris.	Canadian Electrical News. <i>m</i> . Toronto, Ont.
Ann. della Società d. Ing. e d. Arch. Ital. Rome. <i>b-m</i> .	Canadian Engineer. <i>m</i> . Montreal, P. Q.
Architect. <i>w</i> . London.	Canadian Mining Review. <i>m</i> . Ottawa, Ont.
Architectural Record. <i>q</i> . New York.	Century Magazine. <i>m</i> . New York.
Architectural Review. <i>s-q</i> . Boston, Mass.	Chautauquan. <i>m</i> . Meadville, Pa.
Architecture and Building. <i>w</i> . New York.	Chem. Met. Soc. of S. Africa. <i>m</i> . Johannesburg, S.A.R.
Architektonische Rundschau. <i>m</i> . Stuttgart.	Colliery Guardian. <i>w</i> . London.
Atlantic Monthly. <i>m</i> . New York.	Commerce. <i>w</i> . London.
Australian Mining Standard. <i>w</i> . Sydney.	Compressed Air. <i>m</i> . New York.
Automotor and Horseless Vehicle Jour. <i>m</i> . London.	Comptes Rendus de l'Acad. des Sciences. <i>w</i> . Paris.
Bankers' Magazine. <i>m</i> . New York.	Consular Reports. <i>m</i> . Washington, D. C.
Bankers' Magazine. <i>m</i> . London.	Contemporary Review. <i>m</i> . London.
Bankers' Magazine of Australia. <i>m</i> . Melbourne.	Cosmopolitan. <i>m</i> . Irvington, New York.
Berg-und Hüttenmännische Zeitung. <i>w</i> . Berlin.	Deutsche Bauzeitung. <i>b-w</i> . Berlin.
Board of Trade Journal. <i>m</i> . London.	Dingler's Polytechnisches Journal. <i>w</i> . Stuttgart.
Boston Journal of Commerce. <i>w</i> . Boston, Mass.	Domestic Engineering. <i>m</i> . Chicago, Ill.

- Eclairage Electrique. *w.* Paris.
 Electrical Engineer. *w.* London.
 Electrical Engineering. *m.* Chicago, Ill.
 Electrical Review. *w.* London.
 Electrical Review. *w.* New York.
 Electrical World. *w.* New York.
 Electrician. *w.* London.
 Electricien. *w.* Paris.
 Electricity. *w.* London.
 Electricity. *w.* New York.
 Elektrochemische Rundschau. *b-m.* Frankfurt.
 Elektrochemische Zeitschrift. *m.* Berlin.
 Elektrotechnisches Echo. *w.* Magdeburg.
 Elektrotechniker. *b-m.* Vienna.
 Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricita. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, O.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, Tenn.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto, Ont.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, Pa.
 Fire and Water. *w.* New York.
 Forester. *m.* Washington, D. C.
 Forum. *m.* New York.
 Foundry. *m.* Detroit, Mich.
 Gas Engineers' Mag. *m.* Birmingham, England.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Gunton's Magazine. *m.* New York.
 Harper's Weekly. *w.* New York.
 Heating and Ventilating. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Eng. and Surveyors. Peoria, Ill.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago, Ill.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco, Cal.
 Journal Franklin Institute. *m.* Philadelphia, Pa.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Political Economy. *qr.* Chicago, Ill.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, Conn.
 Locomotive Engineering. *m.* New York.
 Locomotive Firemen's Mag. *m.* Peoria, Ill.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Manufacturer's Record. *w.* Baltimore, Md.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, O.
 Master Steam Fitter. *m.* Chicago, Ill.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 McClure's Magazine. *m.* New York.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, Pa.
 Mining and Sci. Press. *w.* San Francisco, Cal.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, Col.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago, I.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, Ind.
 National Builder. *m.* Chicago, Ill.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 North American Review. *m.* New York.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
 Physical Review. *b-m.* New York.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *qr.* Phila., Pa.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, Ind.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago, Ill.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago, Ill.
 Railway & Engineering Review. *w.* Chicago, Ill.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Publicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, N. Y.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* Zürich
 Science. *w.* Lancaster, Pa.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Scribner's Magazine. *m.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, N. Y.
 Southern Architect. *m.* Atlanta, Ga.
 Stahl und Eisen. *s-m.* Düsseldorf.
 State's Duty. *m.* St. Louis, Mo.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, N. J.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston, Mass.
 Technograph. *yr.* Champaign, Ill.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 The House Beautiful. *m.* Chicago, Ill.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, N. Y.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago, Ill.
 Western Railway Club Pro. Chicago, Ill.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, Conn.
 Year Book of Soc. of Eng. Univ. of Minn.
 Zeitschrift für Locomotivführer *m.* Hannover.
 Zeitschrift f. Maschinenbau & Schlosserei. *m.* Berlin.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURE AND BUILDING

CONSTRUCTION AND DESIGN.

Ashlar.

The Face-Bonding of Broken Ashlar. Clarence A. Martin. Suggestions in drawing, building and inspecting certain kinds of stone walls, giving some of the principles that have governed the best work. 900 w. Am Arch—Feb. 11, 1899. No. 25887.

Churches.

Church Architecture in Materials of Clay. Thomas Cusack. Discusses the artistic work and enduring qualities of these materials, and describes some excellent English work in structural terra-cotta, referring also to its extensive use from the twelfth to the sixteenth century in Italy. Ill. 2200 w. Br Build—Jan., 1899. No. 25607 C.

The History of the Frederick Church at Copenhagen. (Die Entstehungsgeschichte der Frederikskirche zu Kopenhagen.) An account of this old Danish church, with reproductions of the original designs of Eigtved and Jardin. 2500 w. 2 plates. Oesterr Monatschr f d Oeffent Baudienst—Feb., 1899. No. 26049 D.

Clock Faces.

Architectural Treatment of Clock Faces. Illustrates and describes successful treatment of this feature of public buildings. 1600 w. Builder—Feb. 11, 1899. No. 26102 A.

Competitions.

General Code Governing Competitions in Design. The text of the General Code adopted by the Architectural League of New York, the National Sculpture Society, and the National Society of Mural Painters, with editorial. 2000 w. Arch & Build—Feb. 4, 1899. No. 25756.

Design.

Common Errors in Architectural Design. Frank Baggallay. Read before the Sheffield Soc. of Arch'ts. and Surv. Considers the use and misuse of ornament; its quality, etc.; the wrong treatment of material; bad proportion; errors in planning and other faults. 9000 w. Builder—Jan. 21, 1899. No. 25656 A.

Exposition.

The Present Condition of the Work at the Champ-de-Mars. (Etat Actuel des Travaux du Champ-de-Mars.) A description of the progress of the work upon the main buildings of the Paris Exposition of 1900, with plan of grounds. 1200 w. Le Génie Civil—Jan. 21, 1899. No. 26003 D.

Fireproofing.

Fireproofing Material. Considers that the proper handling of steel or iron for fireproofing, requires that it be surrounded with concrete so as to leave no air space, and discusses the proper kind of concrete to be used. Ill. 1600 w. Fire & Water—Feb. 18, 1899. No. 26140.

Lessons from the Home Life Building Fire. Thomas Cusack. Presents the opinions of architects on the weather and fire-resisting qualities of terra-cotta as compared with marble, granite, limestone or sandstone. 1100 w. Br Build—Jan. 1899. No. 25609 C.

The Teachings of the New York Fire. Quotes from editorials and articles in the New York papers upon the fire effects on the Home Life Insurance Building, commenting on their justice and intelligence. 3000 w. Br Build—Jan., 1899. No. 25608 C.

Flats.

On London and Paris Flats. Gaspard Tourner. The disposition of apartments in Paris flats is criticized, and illustrations given of London apartment houses. 1000 w. Brit Arch—Feb. 3, 1899. No. 25895 A.

Greek Architecture.

Greek Architecture. George Aitchison. First

Royal Academy lecture. The simplicity of this style, the care taken to design for sunshine, and the climate of Greece, which often renders their mouldings ineffective in moist, sunless climates. The conditions existing in Greece and England are compared, and an interesting study commenced. 5400 w. Builder—Feb. 4, 1899. Serial. 1st part. No. 25902 A.

Greenhouses.

Building a Glass-house. On the construction of greenhouses of various kinds, and the points to be especially considered. 2000 w. Ill. Car & Build—Feb. 3, 1899. No. 25893 A.

Hollow Blocks.

Hollow Block Building vs. Frame. M. W. Lauer. The writer believes a hollow-block house far ahead of frame from all points of argument; but regrets the limits of the material as now manufactured, the range of molds making it impossible to carry out the architect's designs. 1700 w. Brick—Feb., 1899. No. 25708.

Natural Forms.

Nature's Cathedrals. M. H. McDowell. On the decorations and architectural designs taken from nature, especially from the caves and caverns of the under-world. Ill. Am Arch—Feb. 11, 1899. Serial. 1st part. No. 25886.

Parliament House.

The New Parliament Buildings at Budapest. (Das Neue Parlamentsgebäude in Budapest.) A fully illustrated account of the rather ornate structure recently completed at Budapest for the Hungarian Parliament. 3 articles. 3000 w. Schweizerische Bauzeitung—Jan. 7, 14, 21, 1899. No. 26058 each B.

Public Buildings.

The State, War, and Navy Department Building, Washington. G. W. Baird. Illustrates and describes the mechanical features of an office-building covering an area of 565 x 342 feet, and costing \$10,300,000. 3000 w. Eng Rec—Feb. 18, 1899. No. 26119.

Reconstruction.

Reconstruction of the Home Insurance Building, N. Y. Illustrated description of the methods employed in reconstructing portions of a high office building damaged by fire. 2000 w. Eng Rec—Feb. 11, 1899. No. 25843.

Steel Construction.

The Standard Building, New York City. Illustrated description of the method followed in building around and over a large office structure in New York, with details of the steel work. 3000 w. Eng Rec—Feb. 25, 1899. No. 26187.

Theatre.

The Construction of the Imperial Jubilee Theatre in Vienna. (Ueber den Bau des Kaiser-Jubiläums-Stadttheaters in Wien.) Franz Freiherrn v. Krauss. A very full account of this fine new theatre building, with plans and sections. Especial care has been given to the lighting and ventilation. 3500 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 20, 1899. No. 26053 B.

Trusses.

Experiments on Full-Sized Timber Trusses. G. K. Scott-Moncrieff. The object of the experiments described was to ascertain whether trusses, as constructed according to English practice, had any advantage over others designed more in accordance with theory, and more economical in material. Ill. 3000 w. Jour of Roy Inst of Brit Arch'ts—Jan. 14, 1899. No. 25836 B.

HEATING AND VENTILATION.

County Buildings.

Heating of County Buildings, Mason City, Iowa. Illustrated description of a plant for independent buildings exposed to very cold weather. 800 w. Eng Rec—Feb. 4, 1899. No. 25752.

Greenhouse.

Heating the Greenhouse. On the hot-water system and its adaptability to plant growth. 1000 w. Ill Car & Build—Feb. 3, 1899. No. 25894 A.

Low Pressure.

The Advantages of Steam Heating at or Below Atmospheric Pressure. M. O. Kasson. Part of a paper read before the Architects' Club of Chicago. Considers steam circulated by air pressure, explaining the merits, and the methods employed. 2700 w. Met Work—Feb. 18, 1899. No. 25957.

Mechanical Plant.

Heating and Lighting of the University Block, Syracuse, N. Y. Illustrated description of the plant of an 11-story office building, for heating and lighting service. 3500 w. Eng Rec—Feb. 25, 1899. No. 26189.

Residence.

Heating a Private Residence with a Warm Air Furnace. B. Harold Carpenter. Illustrates and describes the arrangement adopted in city residences, which has given satisfactory results. 1000 w. Dom Engag—Feb., 1899. No. 26165 C.

School.

Plenum Ventilation in its Application to Public Elementary Schools. S. Barwise. Shows the necessity of mechanical ventilation, and discusses the exhaust system as well as the plenum. Discussion. 5600 w. Jour of San Inst—Jan., 1899. No. 25781 F.

Shop Heating.

Ventilation and Heating of a Railroad Shop. Illustrated description of the plant by which a number of large detached shops are heated by an air supply from a single source. 1400 w. Eng Rec—Feb. 18, 1899. No. 26123.

Ventilation.

Necessity of Ventilation. H. Eisert. Presented at meeting of American Soc. of Heating and Ventilating Engs. Shows the necessity of constantly renewing the air, the changes wrought by respiration, combustion, etc. 3000 w. Pro Age—Feb. 15, 1899. No. 25944.

PLUMBING AND GASFITTING.**Drainage.**

I. The Construction and Ventilation of House Drains. A. Bostock Hill. II. Combined Drainage. Its pros and cons. Joseph Priestley. Two sanitary papers with discussion presented at the congress at Birmingham, England. 7000 w. Jour of San Inst—Jan., 1899. No. 25777 F.

Hot-Water Supply.

Faults and Causes of Failure in Domestic Hot-Water Supply. Frederick Dye. Part first considers boilers and their effectiveness, and the position of the pipes in the common type of apparatus on the tank system. III. 2200 w. Plumb & Dec—Feb. 1, 1899. Serial. 1st part. No. 26106 A.

House Service.

German and English House Water-Service. (Deutsche und Englische Hausentwässerungen.) M. Knauff. A comparison between German and English methods of house plumbing, both for water supply and drainage connections, indicating the preferable methods in each case. 6000 w. Two articles. Gesundheits-Ingenieur—Jan. 31, Feb. 13, 1899. No. 26068 each B.

Public Baths.

Public Baths and Wash Houses. A. Hessel Tiltman. Abstract of paper read before the Royal Inst. of Brit Archt's, with discussion. Deals with the requirements of such establishments. 3500 w. Builder—Feb. 11, 1899. No. 26103 A.

The Arrangement and Operation of Public Baths. (Ueber Badeeinrichtungen in Gewerblchen Betrieben.) A. Herzberg. With especial reference to douche and spray baths for work-

men's and military baths. 3000 w. Gesundheits-Ingenieur—Feb. 15, 1899. No. 26079 B.

The Mueller Public Baths at Munich. Description with floor plans and elevation, of one of the most elaborate public baths constructed in modern times, covering an area of about 172-000 sq. ft. 1600 w. Eng Rec—Feb. 18, 1899. No. 26120.

MISCELLANY.**Address.**

Address to Students at a Meeting of the Royal Institute of British Architects. George Aitchison. 3000 w. Builder—Jan. 28, 1899. No. 25825 A.

Building Rules.

Building rules of Edinburgh. A copy of the regulations governing the erection of buildings in this city. 1200 w. Arch, Lond—Feb. 3, 1899. No. 25903 A.

The Supervision and Regulation of Building Operations, as exercised by the Edinburgh Dean of Guild Court. David Lyon. A brief account of the origin and nature of this Court, its present form, its jurisdiction and functions. 5400 w. Arch, Lond—Feb. 3, 1899. Serial. 1st part. No. 25904 A.

Competition.

The Californian University Competition. Report of the reception, preparation and judgment of the plans submitted in competition for the "Phoebe A. Hearst architectural plan for the University of California." 1700 w. Arch, Lond—Jan. 27, 1899. No. 25822 A.

Domestic Architecture.

The Modern Woman and Domestic Architecture. F. W. Fitz-Patrick. The writer considers woman's influence has not been for good and urges a more intelligent study of good architecture and the planning of homes. 2500 w. In Arch—Feb., 1899. No. 25935 F.

Fire Prevention.

Testing Station of the British Fire Prevention Committee. Describes a recently opened testing station for fire-resisting materials, methods of construction and appliances, with a general view of the testing chambers and generator, and a view of the instrument room. 1300 w. Engng—Feb. 3, 1899. No. 25907 A.

Fire Risks.

The Fire Risk in Fire-Proof Buildings. A review of an analysis by R. W. Gibson, of the effect of various improvements in the premium to be paid for fire insurance. 1600 w. Eng Rec—Feb. 18, 1899. No. 26121.

Form-Design.

Some Principles of Form-Design in Applied Art. Hugh Stannus. The importance of studying the characteristic qualities of material. 2500 w. In Arch—Feb., 1899. No. 25936 F.

Palestine.

Ancient and Modern Buildings in Palestine. Beresford Pite. Abstract of a lecture, delivered before the Architectural Assn., London. Reviews the architecture and the influences that affected it, with hints of use to those who design buildings for Palestine, and a list of prices of material and work. 1600 w. Arch, Lond—Jan. 27, 1899. No. 25823 A.

Rural Districts.

Some Sanitary Defects in Rural Districts with Suggestions for their Remedy. George H. Smith. Considers briefly the principal defects, such as water supply, drainage, etc., with their remedies. Discussion. 5000 w. Jour of San Inst—Jan., 1899. No. 25779 F.

Stained Glass.

Stained Glass. Christopher Whall. Abstract of lecture read before the Arch. Assn., London. Describes the various steps of the work, and offers some criticisms. Also discussion. 6300 w. Builder—Feb. 11, 1899. No. 26104 A.

CIVIL ENGINEERING

BRIDGES.

Alexandre III.

The Alexander III. Bridge Across the Seine. (Pont Alexandre III. sur la Seine.) A fully illustrated description of the construction and launching of the temporary truss to be used in connection with the erection of the main arch of the bridge. Serial. Part I. 3000 w. 1 plate. *Le Genie Civil*—Feb. 4, 1899. No. 26006 D.

Arch.

Inclined Arch Construction. (Die Schrägstellung der Trägerwände bei Bogenbrücken.) Karl Probst. An investigation of the construction of metal arch bridges with inclined roadways, with illustrations of recent structures in Switzerland. Two articles. 2000 w. *Schweizerische Bauzeitung*—Jan. 21, 28, 1899. No. 26059 each B.

Austria.

Iron Bridge Construction in Austro-Hungary. (Eiserne Brückenbauten in der Oesterreichisch-Ungarischen Monarchie.) M. Foerster. A discussion of the principles of bridge trusses, with diagrams of structures recently erected. 2500 w. *Stahl und Eisen*—Feb. 1, 1899. No. 26042 D.

Concrete.

A Concrete Arch Bridge with Granite Hinges. A description of the Imnau bridge condensed from an article in the *Zeitschrift für Bauwesen*. Ill. 1000 w. *Eng News*—Feb. 16, 1899. No. 25967.

The Concrete-Iron Bridge at Schloss Eichhorn in Moravia. (Beton-Eisenbrücke auf Schloss Eichhorn in Mähren.) J. Melan. A handsome concrete-iron arch bridge on the Melan principle, of about 58 feet span. 1200 w. 1 plate. *Oesterr Monatschr f d Oeffent Baudienst*—Feb., 1899. No. 26048 D.

Drawbridges.

A New Way of Constructing Drawbridges. Brief illustrated description of design of William L. Sampson, which consists of movable cantilever spans having inclines, and aprons adapted to be engaged by the inclines and swung into an angular position. 600 w. *Sci Am*—Feb. 4, 1899. No. 25694.

Düsseldorf.

The New Düsseldorf Bridge Over the Rhine. From *Ueber Land und Meer*. Brief illustrated description. 500 w. *Sci Am Sup*—Feb. 11, 1899. No. 25863.

Girders.

Bridge Girders, Indian State Railways. Drawings, details and particulars of spans with 6, 10, 12 and 20 feet. 250 w. *Ind Engng*—Jan. 14, 1899. No. 25993 D.

Review.

Notable Bridge Construction in 1898. A review of modern work of interest, the removal of historic bridges to make room for structures of greater strength and capacity, characteristics of the most typical examples of recent work, etc. 2800 w. *Eng News*—Feb. 2, 1899. No. 25706.

Roman Bridges.

The Bridges Over the Tiber in Ancient Rome. From *La Nature*. Description and views, given for the purpose of showing the characteristic differences from present types. 1400 w. *Sci Am Sup*—Feb. 18, 1899. No. 25943.

Sohan Bridge.

The erection of Sohan Bridge. Brief illustrated description of the construction of a bridge by means of fan-shaped falsework built out from the base of each pier. 450 w. *Eng Rec*—Feb. 4, 1899. No. 25745.

Truss Bridges.

Standard Plans for 130-ft. Through Truss Bridges; Northern Pacific Ry. Full-page plate

with description of one of the bridges adopted by this road to replace the old wooden bridges. 450 w. *Eng News*—Feb. 2, 1899. No. 25705.

Van Buren St. Bridge.

Change of Approach Span, Van Buren St. Bridge, Chicago. An account of changes made necessary in the construction of the drainage canal, and the exacting conditions imposed upon the engineers. 900 w. *Ry & Engng Rev*—Feb. 18, 1899. No. 26131.

Viaduct.

The Viaduct at Drum and Neuschloss on the Northern Bohemian Transverse Railway. (Die Viaducte bei Drum und Neuschloss auf der Nordböhmischen Transversalbahn.) H. Rosche. With a view of the Korba viaduct and a plan of the country traversed. 1500 w. *Zeitsch d Oesterr Ing u Arch Ver*—Jan. 27, 1899. No. 26054 B.

The Viaduct of Müngsten. From *La Génie Civil*. Describes and illustrates an arched railway bridge, recently erected in Germany, having a span of 560 ft. 2500 w. *Engr, Lond*—Jan. 20, 1899. No. 25632 A.

Youngstown Bridge.

South Market Street Bridge, Youngstown, O. Illustrates and describes the design and erection of a bridge with a main span of 210 1-2 feet, formed of a plate girder arch, and approaches of special design. 1400 w. *Eng Rec*—Feb. 4, 1899. No. 25748.

CANALS, RIVERS AND HARBORS.

Canal Scheme.

A Great Canadian Canal Scheme. Notes the revival of the scheme for the construction of a ship-canal to connect the St. Lawrence River with the great lakes, discussing its advantages, and the route. 1900 w. *Engng*—Feb. 3, 1899. No. 25905 A.

Chicago.

They By-Pass Channel for the Chicago River. Illustrated detailed description. 1800 w. *Eng News*—Feb. 16, 1899. No. 25963.

Dam.

The Castlewood Rock-Fill Dam and the Canal of the Denver Land & Water Co. W. P. Hardesty. Describes the system of this company, which was formed for the purpose of storing water and using it to irrigate land in the vicinity of the city. 4500 w. *Eng & Min Jour*—Feb. 9, 1899. No. 25855.

Dredge.

Ten-Yard Clam-Shell Dredge for the Buffalo, N. Y., Breakwater Construction. Describes and illustrates a dredge that has operated successfully under disadvantageous conditions. 1500 w. *Eng News*—Feb. 2, 1899. No. 25703.

Dredging.

Hydraulic Dredging in Tidal Channels. W. H. Wheeler. Describes the results and cost of works in several countries. 5000 w. *Eng Rec*—Feb. 4, 1899. No. 25751.

Dry Docks.

Masonry or Wooden Dry-Docks. A review of the important light thrown on the relative advantages of timber and masonry graving docks, by the results of the competition for the new Boston structure. 1200 w. *Eng Rec*—Feb. 11, 1899. No. 25842.

Masonry of Wooden Dry-Docks. Brief synopses of papers by William Ledyard Cathcart and Mordecai T. Endicott, given at special meeting to discuss the relative merits, with particular reference to the needs of the U. S. Navy. 2300 w. *R R Gaz*—Feb. 17, 1899. No. 25948.

The Comparative Merits of Timber and Masonry Dry-Docks. Report in full of Mordecai T. Endicott, Chief of the Bureau of Yards and

Docks, respecting materials for the four new dry-docks provided for by the U. S. Congress. 1300 w. Eng News—Feb. 9, 1899. No. 25856.

The New Masonry Dry-Dock at Boston, Mass. Illustrates and describes the leading features of this structure, 788 feet long, giving the elaborate cement specifications in full. 2800 w. Eng Rec—Feb. 4, 1899. No. 25747.

Iron Pier.

Construction of the Old Orchard Pier. Illustrated description of the construction of a steel pier 1800 feet long, supported on jet-piles. 2000 w. Eng Rec—Feb. 11, 1899. No. 25844.

Manchester.

The Manchester Ship Canal. Willard S. Mattox. The influence of this canal on trade, an account of the difficulties that attended its construction, and the dock and quay equipment, and the prospect of its financial success. 2800 w. Ir Age—Feb. 2, 1899. No. 25692.

Masonry.

Masonry. George S. Morison. Briefly discusses materials used in construction, and the special suitability of masonry for works that are to endure. Gives a general outline and reviews the principles that must be followed to secure good results. Ill. 10800 w. Jour W Soc of Eng—Dec., 1898. No. 25671 D.

Nicaragua.

A Review of the Nicaragua Canal Scheme. W. Henry Hunter. A careful discussion of the proposed route, showing its difficulties and uncertainties, and calling for a most careful investigation of the scheme. 6000 w. Engineering Magazine—March, 1899. No. 26098 B.

The Hepburn Bill for a Nicaragua Canal. An editorial discussion of the "amendment" to the Senate bill. 2200 w. Eng News—Feb. 9, 1899. No. 25857.

The proposed Nicaragua Canal. An illustrated comprehensive description of this canal is given, and a comparison of its natural, commercial and political advantages with those of the Panama route. 6400 w. Sci Am—Feb. 18, 1899. No. 25939.

Panama.

A Plan for an Artificial Torrent. (Un Projet de Torrent Artificiel.) Leo Dex. A discussion of the plan of M. Bartissol to control the waters of the Chagres for use in a form of hydraulic mining in connection with the excavation of the Panama canal. 3500 w. La Revue Technique—Jan. 25, 1899. No. 26017 D.

The New Panama Canal. Discusses the present status and future prospects of this undertaking. Gives the history of the work under Ferdinand de Lesseps, and of the investigations made by the new company, the amount of work done, the cost of completion, etc. Also editorial. Ill. 4500 w. Sci Am—Feb. 4, 1899. No. 25693.

Retaining Walls.

Construction of Retaining Walls for the Sanitary District of Chicago. James W. Beardsley. Illustrated detailed description of the work, with discussion. 6800 w. Jour W Soc of Eng—Dec., 1898. No. 25672 D.

River Improvement.

The Water Hyacinth. Describes the results of the government investigating board charged with finding some means of exterminating this plant, which is rapidly clogging many navigable streams in Florida and Louisiana. 700 w. Eng Rec—Feb. 4, 1899. No. 25744.

Water Hyacinth Obstructions in Southern Rivers. Reviews the results of the experiments and investigations conducted by the Board appointed by the government. 1400 w. Naut Gaz—Feb. 2, 1899. No. 25765.

Sault Ste. Marie.

Sault Ste. Marie Canal. Views of the old state lock, with a historical resume of the development of the canal. 800 w. Marine Rev—Feb. 23, 1899. No. 26201.

Sea Encroachment.

Sea Encroachment and Case Groynes. Illustrates and describes the groyne invented and patented by Edward Case. The object is to utilize the destructive forces of the sea for constructive purposes. 2000 w. Engng—Jan. 27, 1899. No. 25793 A.

Sluice Recorder.

Automatic Sluice Recorder for the Manchester Ship Canal. A. J. Mentha. Description with drawings of the instrument for ascertaining the quantity of water flowing into or from the canal. Also describes the installation. 1500 w. Prac Eng—Jan. 27, 1899. Serial. 1st part. No. 25826 A.

IRRIGATION.

Economy.

The Conservation of Soil Moisture and Economy in the Use of Irrigation Water. E. W. Hilgard and R. H. Loughridge. Considers the amount of water required by crops, the most economical mode of using irrigation water, and the conservation of the moisture imparted to the soil. 3200 w. Ind Forester—Dec., 1898. No. 25681 D.

Reservoir.

Harnessing the Nile. Frederic Courtland Penfield. An account of the gigantic engineering undertaking, which will create a large lake in the desert of Africa, and control it so that the water may be turned into distant channels at will. Ill. 3500 w. Century Mag—Feb., 1899. No. 25600 D.

MISCELLANY.

Cement.

Cement Specifications and Cement Testing. Robert W. Lesley. Abstract of an interesting paper recently read before the Eng's Club of Phila. on the wide divergence between specifications for the same material for the same purposes, with hints for standardizing, with specifications and tests. Ill. 3700 w. Eng Rec—Feb. 25, 1899. No. 26188.

Russian Portland Cement Specifications. These are noteworthy for prescribing two sets of tests, one for the laboratory on the work, and the other for the more careful investigations possible in the laboratories of expert testing establishments. 2800 w. Eng Rec—Feb. 18, 1899. No. 26118.

Specifications for Cement. A copy of the specifications for testing cement, based on actual tests, issued by the Cement Users Testing Assn., of London. 1400 w. Arch & Build—Feb. 4, 1899. No. 25757.

The Plant of the Michigan Portland Cement Company, Coldwater, Mich. Frederick H. Lewis. Illustrated description of a plant of 4,000 bbls. daily capacity, using wet processes and rotary kilns. 1500 w. Eng Rec—Feb. 25, 1899. No. 26185.

Cement Mortar.

Ingredients of a Cubic Yard of Cement Mortar and the Cost. L. C. Sabin. Discusses methods of obtaining approximate results, giving tables with explanation of their use. 1100 w. Munic Engng—Feb., 1899. No. 25678 C.

Concrete.

Some Recent Tests of Concrete Cubes. W. A. Rogers. An account of experiments made in connection with tests of cement furnished for the work on the elevation of tracks in Chicago. 2000 w. Ry & Engng Rev—Feb. 18, 1899. No. 26133.

The Influence of Imbedded Metal on the Properties of Mortar and Concrete. (Influence des Armatures Métalliques sur les Propriétés des Mortiers et Bétons.) A general discussion, by Chief Engineer Considère, of the behavior of structures of metal and concrete, based upon experiments by the department of Ponts et Chaussées. Serial. Part I. 3000 w. Le Génie Civil—Feb. 4, 1899. No. 26007 D.

The Proportions of Concrete. A paper giving methods of estimating the relative proportions of cement needed for varying proportions and sizes of sand and stone. 1200 w. Eng Rec—Feb. 11, 1899. No. 25848.

Earthwork.

The Measurement of Earthwork. In view of the different results obtained when earthwork is measured in different ways, the courts in the various states are sometimes called upon to establish one method as standard. The Supreme Court of California has recently fixed such a standard in a case reviewed under this title. 1000 w. Eng Rec—Feb. 4, 1899. No. 25743.

Road.

Mr. Alfred Holt's Plateway Scheme for Heavy Traffic. Illustrates and describes this system,

stating its merits. 2200 w. Automotor Jour—Jan., 1899. No. 25642 A.

New Jersey Roads. A review of the methods of building and repairing state roads. 1400 w. Eng Rec—Feb. 25, 1899. No. 26183.

Surveying.

A Stadia Diagram. Morris K. Trumbull. Gives a stadia diagram designed with a view to lessening the time required for the reduction of the notes, with a brief description of the methods used in its construction. 4400 w. Jour W Soc of Eng—Dec., 1898. No. 25675 D.

ECONOMICS AND INDUSTRY

COMMERCE AND TRADE.

Agricultural Machinery.

Agricultural Machinery in Germany. Prepared by the Philadelphia Commercial Museum. American trade in this line shows an advance of over 50 per cent. in ten years. Information concerning the machines most widely used. 2000 w. Am Mfr & Ir Wld—Feb. 3, 1899. No. 25790.

Bicycles.

American Bicycles and Vehicles in England. Extracts from the annual report of Consul Halstead, of Birmingham, concerning the bicycle business. Discusses the condition of the market in England, the status of the English manufacturer, etc. 4000 w. U S Cons Repts, Vol LIX—Feb., 1899. No. 25661 D.

Brazil.

American Trade in Brazil. C. Paulo Rei. An article objecting to a statement made, that this is not a favorable time for the increase of American trade, and explaining the present conditions. 2000 w. Ir Age—Feb. 16, 1899. No. 25933.

British Commerce.

Exports and Imports. A resume and editorial discussion of a paper by Sir Robert Giffen read at a meeting of the Royal Statistical Society. A clear and complete contribution to the problem of national economics, showing that international trade means more than the buying and selling of goods, and that the subject in its entirety presents a different aspect. 2300 w. Engng—Jan. 20, 1899. No. 25614 A.

The Excess of Imports. Sir Robert Giffen. A summary of the principal statements and conclusions of a paper read before the Royal Statistical Society. 2500 w. Col Guard—Jan. 20, 1899. No. 25625 A.

British Trade.

British Trade in South America. Extracts from reports by Mr. Worthington, special commissioner to investigate the condition of British trade in certain South American countries. Report concerning Chile. 9600 w. U S Cons Repts, No. 341—Feb. 3, 1899. No. 25659 D.

Excess of Imports in British Trade. Comment on some points in the paper read by Sir Robert Giffen before the Royal Statistical Society. 1000 w. Bradstreet's—Feb. 4, 1899. No. 25758.

China.

United States Trade at Chefoo. Tabulated statements of imports with information of interest to American exporters. 1800 w. U S Cons Repts, No. 348—Feb. 11, 1899. No. 25880 D.

Coal Syndicate.

The Rhenish-Westphalian Coal Syndicate. George Blake Walker. Abstract of paper read at meeting of the Midland Inst. of Min., Civil and Mech. Eng. with discussion. Reports the continued success of this combination, and the conditions affecting it. 2200 w. Col Guard—Feb. 3, 1899. No. 25914 A.

The Rhenish-Westphalian Fuel Syndicates. Brief summary of information concerning these combinations which have so largely contributed

to the prosperity of the German coal trade. 1200 w. Col Guard—Jan. 20, 1899. No. 25619 A.

Combinations.

Industrial Combinations. Discusses the remarkable number of corporations, and the danger. 900 w. Bradstreet's—Feb. 18, 1899. No. 25954.

Competition.

America and Germany as Export Competitors and Customers. Louis J. Magee. Giving especially a view of the economic legislation of Germany and the influence which it has exerted upon trade. 3000 w. Engineering Magazine—March, 1899. No. 26091 B.

American Competition in the German Iron Market. Jacob Muench. An account of the German iron industry and a discussion of the possibilities of foreign competition. 1500 w. Ir Trd Rev—Feb. 2, 1899. Serial. 1st part. No. 25717.

Egypt.

Egypt's Promising Market for American Goods. Prepared by the Phila. Commercial Museum. On the promising outlook in this market. 1800 w. Am Mfr & Ir Wld—Feb. 10, 1899. No. 25891.

Far East.

A Japanese View of Far Eastern Affairs. Editorial review of a treatise prepared by Mr. Nakao Komamosuke. Notes some of the interesting points, especially in relation to Japan's future policy and its influence on the industry and trade. 1000 w. Engng—Jan. 27, 1899. No. 25795 A.

Hong Kong.

Increase of United States Trade with Hong Kong. Reports a permanent increase of trade and discusses some commercial questions of interest. 2500 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25665 D.

Imports.

United States Imports at Bristol. Information concerning corn, barley, bacon, cattle, and iron manufacturers. 1500 w. U S Cons Repts, No. 343—Feb. 6, 1899. No. 25771 D.

Iron Trade.

Pittsburg Pig Iron in England. Clippings from British journals in regard to the shipping of 2000 tons of pig iron to Birmingham. 2000 w. U S Cons Repts, No. 346—Feb. 9, 1899. No. 25827 D.

The English Iron Market. Willard S. Mattox. On the standing of American iron in England, the reasons why orders cannot now be filled. Also reports of the English iron districts, and observations on the shipping. 1600 w. Ir Age—Feb. 16, 1899. No. 25934.

United States Iron and Tools in England. Information of interest and importance concerning trade in these products. 5200 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25663 D.

Japan.

Why Japan Left China Behind. J. Morris. The first of a series of articles, showing the influence of engineering in opening the interior of Japan, and contrasting their achievements with

the Chinese. 1500 Ind w. & East Engr—Jan., 1899. Serial. 1st part. No. 26112 D.

Railroad Monopoly.

The Outworkings of a Railroad Monopoly. Clarence Deming. A review of the outworkings of the Consolidated Company, whose control embraces all roads but one in Connecticut, and most of southern New England, also four leading Sound boat lines. 1800 w. R R Gaz—Feb. 3, 1899. No. 25730.

Rubber Trust.

The Rubber Trust. Editorial review and articles of interest relating to the trust. 10500 W. Ind Rub Wild—Feb. 1, 1899. No. 25753 D.

South America.

United States Cotton Fabrics in South America. Urging the introduction of these products by United States manufacturers. 1200 w. U S Cons Rept, No. 329—Jan. 20, 1899. No. 25773 D.

Tariff.

Changes in Mexican Tariff. A copy of a decree of Dec. 30, 1898. 1700 w. U S Cons Repts, No. 342—Feb. 4, 1899. No. 25755 D.

Trade Extension.

Does Trade Follow the Flag? Lord Masham. A reply to an article by Lord Farrar. Favors protection for British trade. 2000 w. Contemporary Rev—Feb., 1899. No. 26199 D.

Trade Methods.

American Goods and Trade Methods in England. Concerning the attempts made to sell American paper; American wheat; factory sight-seeing; pen manufacture, etc. 2500 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25662 D.

Trade Names.

Trade Names. Cites cases showing the attitude of the Court of Chancery, England, towards those who imitate the trade names of rival firms. 2500 w. Engng—Jan. 27, 1899. No. 25797 A.

Trade Relations.

Foreign-Trade Policies. A request for information was sent out in regard to the policies adopted to extend foreign commerce. The replies are given. 18000 w. U S Cons Repts, Vol. LIX—Feb., 1899. No. 25660 D.

Some Features of Our Foreign Trade This Year and Last. A review of imports and exports of the United States, and the causes that have influenced the trade. 1200 w. Bradstreet's—Feb. 18, 1899. No. 25956.

Whom We Trade With and How. An interesting review of the United States trade for 1898, showing the value of exports and imports, and many interesting details. 1200 w. Bradstreet's—Feb. 25, 1899. No. 26195.

CURRENCY AND FINANCE.

Clearing-House.

The Clearing-House. John H. Blacklock. A paper written with the object of bringing about the organization of Clearing Houses in towns where the banks are comparatively few in number. Gives methods of operation, constitution, rules and practical working forms. 6800 w. Bankers' Mag., N. Y.—Feb., 1899. No. 25882 D.

Currency Reform.

Banking and Currency Reform from a Country Standpoint. John W. Fries. Some account of banking business as conducted at present, with discussion of the system of loaning money on call, and the need of country banks having the privilege of issuing circulating notes based on their general assets. 4000 w. Bankers' Mag., N. Y.—Feb., 1899. No. 25881 D.

Funds.

Reserve and Sinking Funds in Relation to Mining and Manufacturing Companies. George Johnson. Discusses what a reserve fund is, and the purposes for which it is created; its investment, and proper method of recording. And similar discussion of a sinking fund. 2800 w. Ir & Coal Trds Rev—Jan. 27, 1899. No. 25807 A.

Indian Currency.

The Indian Currency. John Lubbock. Discussion of the proposal made by the Indian Government to the Home Government, with suggestions made with a view to giving India a satisfactory currency. 4400 w. Contemporary Rev—Feb., 1899. No. 26200 D.

Investments.

The Money Centers and Tramway Opportunities of the world. A survey indicating the lines upon which further work can be done in particular sections. Part first considers the opportunities in Europe. 3000 w. St Ry Jour—Feb., 1899. Serial. 1st part. No. 25727 D.

Japan.

Foreign Capital in Japan. Discusses the prospects of land tenure under the new treaties, taking a rather hopeful view of the question. 2400 w. Engr, Lond—Feb. 3, 1899. No. 25917 A.

GOVERNMENTAL CONTROL.

Patents.

On the Validity of Mineral Wool Patents. A. D. Elbers. Gives extracts relating to compositions contained in early patents and reviews enumerated patents for the purpose of judging of their validity. 1800 w. Am Mfr & Ir Wld—Feb. 17, 1899. No. 26139.

LABOR.

British Workmen.

The Future of the British Workman. Presidential address delivered by Mr. John Inglis before the Institute of Marine Engineers, with editorial comment. 5000 w. Engng—Jan. 27, 1899. No. 25796 A.

Labor Question.

Some Recent Phases of the Labor Question. Part first considers coal miners and their unions, in the light of statistics furnished by the Labor Department of the British Board of Trade. 2300 w. Ir & Coal Trds Rev—Jan. 20, 1899. Serial. 1st part. No. 25636 A.

Railway Labor.

Condition of Railway Labor in Europe. Walter E. Weyl. A study of the general conditions of railway labor in a number of characteristic countries of Europe, undertaken to furnish material by which to judge American experience. 40000 w. Bul of U S Dept of Labor—Jan. 1899. No. 26124 D.

Strike.

The Weavers' Strike of Crefeld. An account of a strike among the weavers of this city of Prussia, with a copy of the agreement that is to govern them during the three months' truce agreed upon. 1000 w. U S Cons Repts, No. 344—Feb. 7, 1899. No. 25770 D.

Trade Disputes.

Arbitration and Conciliation in Trade Disputes. Discusses compulsory and voluntary arbitration, and the effect of public sentiment. 2300 w. Builder—Jan. 21, 1899. No. 25655 A.

Trade Unions.

The Yellow Book on Trade Unions in 1897. Comment on the recently issued English report of the Labor Department of the Board of Trade. 2000 w. Engr, Lond—Jan. 27, 1899. No. 25812 A.

Tropics.

The Labor Problem in the Tropics. W. Alleyne Ireland. On the necessity of securing a reliable labor supply to cultivate tropical products, as the natives will not work, giving a description of the successful contract system existing in the colony of British Guiana. 4000 w. Ap Pop Sci M—Feb., 1899. No. 25667 D.

MISCELLANY.

Cuba.

Cuba's Industrial Problems. Reviews the present conditions in the island and considers the serious problems to be solved in developing the

industries and fitting the people for self-government. 4000 w. Gunton's Mag—Feb., 1899. No. 25774 C.

Exhibition.

South African Exhibition. An account of the industrial and art exhibition in Grahamstown, and the products represented. 1000 w. U S Cons Repts, No. 352—Feb. 16, 1899. No. 25925 D.

Flash-Point.

The Flash-Point of Burning Oil. Editorial discussion of the effort in England to raise the flash-point to 100 deg. Fahr., and the effect it will have. 2500 w. Ind & Ir—Jan. 27, 1899. No. 25816 A.

Fuel Cost.

The Fuel Factor in the Cost of Production. Statistics showing the reduction in the fuel cost due to mechanical contrivances for getting and handling the coal, and preparing it for the use intended. 1500 w. Col Guard—Feb. 3, 1899. No. 25913 A.

Germany.

British View of Germany's Industrial Development. From the report of Mr. Gastrell, commercial attache to the British embassy in Berlin. Thinks success is due to mercantile enterprise and thoroughness of the people. 1200 w. U S Cons Repts, No. 357—Feb. 23, 1899. No. 26144 D.

Lumber.

American Lumber. B. E. Fernow. The value of this industry in the United States, with very interesting statistics, and the need of restorative measures. 3000 w. Chau—Feb., 1899. No. 25601 C.

Paris Exposition.

American Representation at the Paris Exposition of 1900. Ferdinand W. Peck. Address delivered before the Nat. Assn. of Mfrs. at Cin-

cinnati. On the commercial benefit and patriotic duty involved. 2000 w. Elec Eng, N. Y.—Feb. 9, 1899. No. 25839.

The Paris Exhibition of 1900. A statement of some of the delays and difficulties attending the preparation. 3700 w. Engng—Feb. 3, 1899. No. 25909 A.

Russia.

Russia as a World Power. Charles A. Conant. Considers the economic development of Russia is destined to soon make her the great competitor of the Anglo-Saxon race for the commercial and military supremacy of the world. 4300 w. N Am Rev—Feb., 1899. 25569 D.

Stone.

The Testing of Natural Stones in the Years 1895-96 and 1897-98. (Prüfung Natürlicher Gesteine in den Betriebsjahren 1895-96 bis 1897-98.) M. Gary. A very full report of the important work done by the Berlin Testing Laboratory during the past three years in investigating the properties of many kinds of building stone. An important paper. 15000 w. Mitt aus den Kgl Tech Versuchsanstalt—No. 5, 1898. No. 26043 G.

Technical Education.

Technical Education in Germany. An account of a conference to discuss German trade and manufacturing interests, with the resolutions passed. 700 w. U S Cons Repts, No. 329—Jan. 20, 1899. No. 25772 D.

Wheat Supply.

The Coming Exhaustion of the World's Wheat Supply. Extract from the presidential address of Sir William Crookes at the last meeting of the British Assn. for the Adv. of Science. Statistics are given showing the outlook under present conditions, and suggestions given of what science can do to remedy these conditions. 2500 w. Eng News—Feb. 9, 1899. No. 25858.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cable.

An All-British Cable System. Archibald S. Hurd. Considers the importance of connecting England directly with her colonies, outlines the scheme, and estimates the cost. 3800 w. Nineteenth Cent—Feb., 1899. No. 26196 D.

Coharers.

Experiments on Coharers. Alfred G. Dell. Describes laboratory experiments made to determine something concerning the action of coharers, giving results. 1200 w. Elec Eng., N. Y.—Feb. 16, 1899. No. 25923.

Duplex.

The Recording Duplex Instrument. (Das Recorder-Gegensprechen.) A. Luers. A description of the application of the Kelvin siphon recorder as a receiver in duplex telegraphy. 3500 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26077 B.

Exchange.

The New Exchange of the Central New York Telephone and Telegraph Co., at Syracuse, N. Y. Max Loewenthal. An illustrated detailed description of the plant, with historical review of the company. 4000 w. Elec. Eng, N. Y.—Feb. 2, 1899. No. 25685.

Review.

The Year's Progress in Telephony and Telegraphy. Edward E. Clement. Review of the year 1898, noting the improvements, the part taken in the Spanish-American war, etc. Ill. 14500 w. Elec Engng—Feb., 1899. No. 26179 C.

Symbols.

The Telegraphic Transmission of Symbols. (Verfahren zur Telegraphischen Uebertragung von Zeichnungen.) Dr. J. Walter. A system of

symbolical telegraphing by the use of a diagram of squares containing letters or syllables, the squares being indicated by numbers and letters. 3000 w. Elektrotech Zeitschr—Jan. 18, 1899. No. 26070 B.

Telephony.

The Past Year's Advance in the Art of Telephony. Kempster B. Miller. A review of improvements during 1898, which consist mainly in the line of the perfection of details. Ill. 2800 w. Elec Wid—Feb. 18, 1899. No. 26142.

DISTRIBUTION.

Distributing.

Systems of Distributing and Generating Electricity. F. J. Warden-Stevens. Part first considers the two- and three-wire systems, and high and low pressure. 2000 w. Arch, Lond—Jan. 20, 1899. Serial. 1st part. No. 25640 A.

Transformers.

A New Transformer Diagram. Frank G. Baum. Describes a new method for obtaining the instantaneous values of the primary and secondary currents and magnetic flux of a transformer. 2500 w. Phys Rev—Feb., 1899. No. 26181 D.

ELECTRO-CHEMISTRY.

Accumulators.

Latest Progress in the Application of Storage Batteries. Joseph Appleton. Abstract of a paper read before the N. Y. Elec. Soc. Describes the conditions and methods of operation of the most interesting installations, and gives results from actual practice showing the present standing of storage batteries. Ill. 5800 w. Elec Wid—Feb. 4, 1899. No. 25686.

Notes on the Employment of Accumulators for

Electrically Propelled Vehicles. Percy Northey. Read before the Automobile Club of Great Britain and Ireland. A discussion of points of interest in securing satisfactory working of accumulators, and their employment for propelling vehicles. Also discussion. 6200 w. Automotor Jour—Jan., 1899. No. 25644 A.

See Street and Electric Tramways.

Alloys.

Some Investigations in Connection with the Electro-Deposition of Alloys. Sherard Cowper-Coles. Part first is a historical review of inventions in this field, and experiments made. 2400 w. Ind & Ir—Jan. 27, 1899. Serial. 1st part. No. 25815 A.

Caustic Soda.

Gravity-Electrolytic Processes for the Production of Caustic Soda. G. H. Robertson. Reviews the processes that have been devised and presents the claims of the latest introduced by the Oesterreichischer Verein für Chemische und Metallurgische Produktion, in Bohemia. 1500 w. Elect'n, Lond—Jan. 27, 1899. No. 25820 A.

Electrolytic Processes.

Electrolytic Processes for the Extraction, Separation and Refining of Metals. Dr. D. Tommasi. Stating the advantages of the Tommasi electrolyzer, and discussing in part first the process for treating argentiferous lead. Ill. 3700 w. Elec Wld—Feb. 25, 1899. Serial. 1st part. No. 26172.

Electroplating.

Electroplating the Hulls of Vessels. Extracts from the report of A. A. Kundson concerning the condition of the hull of the tug "Assistance," which was electroplated with copper in 1895. Gives the method used and gives reasons for considering the method an improvement in copper sheathing. Ill. 1700 w. Elec Eng, N. Y.—Feb. 2, 1899. No. 25682.

Le Sueur Process.

The Le Sueur Process for the Electrolytic Production of Alkali and Chlorine. An account of the latest developments of this process which is now working with fair success. Also editorial. 2200 w. Elect'n, Lond—Feb. 10, 1899. No. 26109 A.

Voltaic Cell.

The Primary Voltaic Cell as a Transformer of Energy. Henry H. Norris. Read before the Cornell Elec. Soc. Considers the elements of the cells, faults of primary cells, commercial efficiency and their operation as electric and current generators, etc. 3000 w. Sib. Jour. of Engng—Feb., 1899. No. 26178 C.

ELECTRO-PHYSICS.

Conductivity.

Influence of the Surrounding Dielectric on the Conductivity of Copper Wire. Joseph Francis Merrill. A report of investigations and their results, with a brief review of the conclusions reached by Prof. Sanford and Prof. Carhart. 5000 w. Phys Rev—Feb., 1899. No. 26182 D.

The Electrolytic Conductivity of Pure Substances (Ueber das Elektrolytische Leitvermögen Reiner Substanzen). R. Abegg. An investigation of electrolytic conductivity, based upon the modern theory of Arrhenius. 1500 w. Zeitschr f Electrochemie—Feb. 2, 1899. No. 26080 G.

Discharge.

The Action of Magnetized Electrodes upon Electrical Discharge Phenomena in Rarefied Gases. C. E. S. Phillips. Describes experiments in this field and the apparatus used. 1500 w. Elect'n, Lond—Feb. 3, 1899. No. 25900 A.

Electric Spark.

The Constitution of the Electric Spark. Arthur Schuster and G. Hemsalech. Read before the Royal Society. Investigation undertaken primarily to measure the velocity of diffusion, with the special view of comparing different metals, and different lines of the same metal. 2500 w. Nature—Feb. 9, 1899. No. 25995 A.

Generation.

Electricity Direct from Coal. A. J. Rogers. Read at the meeting of the Northwestern Elec. Assn. A review of what has been done in this field, and the importance of having the problem solved. 1800 w. Elec, N. Y., Feb. 1, 1899. No. 25690.

Interrupter.

An Electrolytic Current Interrupter. (Ein Elektrolytischer Stromunterbrecher.) Dr. A. Wehnelt. An ingenious form of interrupter for us with induction coils; consisting of a lead plate and platinum wire as electrodes in dilute sulphuric acid. By the intermittent action the current is interrupted and restored in a very effective manner. 2000 w. Elektrotech Zeitschr—Jan. 26, 1899. No. 26073 B.

Electrical Interrupters for High-Tension Transmission for Continuous Currents. (Interrupteurs Electriques des Transformateurs à Haute Tension pour Courants Continus.) O. Rochefort. Describing several forms of mercurial interrupters for use in connection with the transforming of continuous current. 2000 w. Soc Ing Civ de France—Dec., 1898. No. 26026 F.

The Wehnelt Electrolytic Current Interrupter for Induction Coils. Dr. A. Wehnelt, in Elektrotechnische Zeitschrift. Describes experiments, giving results. Ill. 1200 w. Elec Eng, N. Y.—Feb. 16, 1899. No. 25924.

Magnetic Fields.

On Oscillatory and Rotary Magnetic Fields, and the Theory of the Single-Phase Motor. Michael B. Field. An investigation of the analysis and synthesis of various forms of magnetic fields, with the view of arriving at a satisfactory standpoint from which to attack the theory of the single-phase motor and to develop an approximate method for calculating the same. 2400 w. Elec Rev, Lond—Feb. 10, 1899. Serial. 1st part. No. 25990 A.

Magnetism.

"Residual" and "Permanent" Magnetism. J. Warren. An explanation of the writer's use of these terms, with a table giving residual magnetism results, obtained in some experiments. 700 w. Elec, Lond—Jan. 13, 1899. No. 25610 A.

Vibration Theory.

Agreement of the Thermodynamic or Vibration Theory with the Theory of Maxwell. (Übereinstimmung des Thermodynamischen oder Vibrationstheorie mit der Theorie von Maxwell.) Rudolph Mewes. A mathematical discussion of the agreement of the wave theory with that elaborated in Maxwell's "Electricity and Magnetism." 2000 w. Elektrizität—Feb. 4, 1899. No. 26082 B.

GENERATING STATIONS.

Brazil.

The Electrical Plant at Para, Brazil. (Das Elektrizitätswerk Pará, Brasilien.) Christen G. Host. An interesting account of the electric power plant and trolley lines recently constructed in the city of Para. 4000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26075 B.

Currents.

Wagner Method for Deriving Polyphase from Single-Phase Currents. Describes a method devised by Herbert A. Wagner for deriving two or more alternating currents differing from one another in phase from a source of electricity supplying alternating currents of single phase. 700 w. Elec Eng, N. Y.—Feb. 2, 1899. No. 25683.

Design.

Trend of Central Station Design. B. J. Arnold. Read at meeting of the Northwestern Elec. Assn., at Milwaukee. Notes the points in accepted practice, discussing each briefly 3400 w. Elec, N. Y.—Feb. 8, 1899. Serial. 1st part. No. 25841.

Dynamos.

Points to Consider in a Dynamo. Arthur L. Rice. Briefly considers such points as can be determined without the test of continuous use. Diagrams. 1500 w. Engr, U. S. A.—Feb. 1, 1899. No. 25792.

Glasgow.

Glasgow Corporation New Electric Supply Work. A short history of this enterprise, with illustrated description of the new works. 3500 w. Elect'n, Lond—Feb. 3, 1899. No. 25899 A.

Installation.

Electricity at the Polhemus Memorial Clinic. Illustrates and describes a plant of exceptional thoroughness, and unique applications. 4300 w. Am Elect'n—Feb., 1899. No. 25828.

New York.

The Mammoth Generating Plant of the Third Avenue Railroad Co., New York City. Brief account of this power house, which will be the largest ever projected. Ill. 600 w. Elec Eng, N. Y.—Jan. 5, 1899. No. 25657.

Niagara.

The Birkinbine Plan for Utilizing Niagara Gorge Power. Brief illustrated description of the plan proposed. 600 w. Elec Eng, N. Y.—Feb. 9, 1899. No. 25838.

Paderno.

European Transmission Practice and the Water Power and Electric Plant at the Adda Rapids, near Paderno, Italy. Illustrates and describes an interesting hydraulic plant, where 13000 h. p. is transmitted a distance of 20 miles. 3800 w. Elec Eng, N. Y.—Feb. 9, 1899. Serial. 1st part. No. 25837.

Pittsburg, Pa.

Design and Construction of the 20th Street Power Station of the Consolidated Traction Company, Pittsburg, Pa. G. F. Greenwood. A statement of the existing conditions which made necessary the construction of this new station, with description of the plant. 5800 w. Pro of Eng's Club of W. Penna—Dec., 1898. No. 25859 D.

Sparking.

The Short-Circuiting of the Bobbins and the Commutation of the Current of a Continuous Current Armature. (Ueber den Kurzschluss der Spulen und die Kommutation des Stromes eines Gleichstromankers.) E. Arnold and G. Mie. A highly mathematical discussion deriving equations for various conditions, with especial relations to the reduction of sparking. Serial, Part I. 4000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26076 B.

St. Anthony's Falls.

Power House and Shops of Twin City Rapid Transit Company. Illustrated description of the water power plant at St. Anthony's Falls, method of distributing current, stations, shops, cars, etc. 5400 w. St. Ry Rev—Feb. 15, 1899. No. 25958 C.

HEATING AND WELDING.**Alternating.**

Heating Appliances for Alternating Currents. (Appareils Thermiques pour Courants Alternatifs.) R. B. Ritter. Illustrating and describing tic devices of the Alioth Company, of Bâle, Switzerland, including kitchen and laundry apparatus. 1500 w. L'Electricien—Jan. 21, 1899. No. 26036 B.

Cooking.

The Parvillée System of Electric Heating. (Appareils de Chauffage par l'Electricité Système Parvillée.) J. A. Montpellier. A descrip-

tion of electric cooking devices of the Parvillée design, in which the heating effect is produced by the introduction of a metallo-céramique resistance. 1200 w. L'Electricien—Feb. 11, 1899. No. 26038 B.

LIGHTING.**Arc Lamps.**

A Comparison of the New Volta Lamps, with the Old System. (Ueber die Beleuchtung durch die Neuen Volta Lampen im Vergleich zu dem Alten System.) Dr. W. Wedding. A discussion of photometric tests, by which the greatly superior efficiency of the new lamp is shown; there being either an increase in illumination or a reduction in cost. 4500 w. Elektrotech Zeitschr—Jan. 19, 1899. No. 26071 B.

A New Regulator for the Arc Lamp. (Nouveau Régulateur de Lampe à Arc.) Marcel Deprez. An illustrated description of the Combiér & Duflos arc lamp, with an analysis of its action. 1500 w. Le Génie Civil—Jan. 21, 1899. No. 26004 D.

A 95 Volt Arc. Alton D. Adams. Describes a new arc lamp which has an induction coil in shunt with its regulating spools. 900 w. Elec. Eng., N. Y.—Feb. 23, 1899. No. 26166.

Arc Lamp Regulation. Alton D. Adams. Discusses the power consumed in regulating resistance, and how it may be utilized. 1000 w. Elec. Eng. N. Y.—Feb. 16, 1899. No. 25922.

The A B C Arc Lamps. An illustrated detailed description. 3000 w. Elec. Rev. Lond.—Feb. 10, 1899. No. 25992 A.

Candle Power.

On the use of the Methven Standard with Blackened Chimney. R. A. Fessenden. Calls attention to the error arising from this practice. 500 w. Elec Wld—Feb. 25, 1899. No. 26171.

The relation between Mean Spherical and Mean Horizontal Candle Power of Incandescent Lamps. R. A. Fessenden. Describes methods of making tests to determine if the distribution factor could be predicted from the length, position and shape of the filament, giving results. Ill. 800 w. Elec Wld—Feb. 25, 1899. No. 26170.

Carbons.

Biography of an Arc Lamp Carbon. An account of the material used and how the carbons are made. Illustrating the processes used in the works of the Washington (Pa.) Carbon Co. 1600 w. Am Elect'n—Feb., 1899. No. 25833.

Filaments.

Maxim Method of Making Filaments for High Voltage Incandescent Lamps. Illustrates the apparatus used and describes the process. 1400 w. Elec Eng, N. Y.—Feb. 9, 1899. No. 25840.

Gibraltar.

The Electric Lighting of Gibraltar. Illustrates and describes a recently inaugurated system for public and private electric supply, chiefly for lighting purposes. 1800 w. Elect'n, Lond—Jan. 20, 1899. No. 25641 A.

Head-Light.

See Railway Affairs, Motive Power.

Inductive Loads.

Inductive Loads (Arc Lamps and Motors) on Alternating-Current Transformers. D. C. Jackson. Abstract of a paper read before the Northwestern Elec. Assn. at Milwaukee. Calls attention to the effect of arc lamps, or fan motors, when connected to transformers. 1500 w. Elec Wld—Feb. 4, 1899. No. 25687.

Nernst Lamp.

Nernst's Electric Lamp. James Swinburne. Gives a brief review of the position of electric lighting and describes the Nernst lamp. Also considers the future outlook. Discussion. 4500 w. Jour Soc of Arts—Feb. 10, 1899. No. 25999 A.

Wiring.

Electrical House-Wiring Regulations. Comment on three papers read before the Inst. of Elec. Eng. (London), urging the putting installation business on a sound basis. 3500 w. Elec Rev, Lond—Jan. 27, 1899. No. 25817 A.
Interior Electric Wiring. H. N. Gardner. A few rules applying to the wiring of a frame house of moderate cost. 2000 w. W Elect'n—Feb. 18, 1899. No. 26168.

MEASUREMENT.**Alternating Current.**

New Measuring Instruments for Alternating Currents. (Neue Wechselstrommess-Instrumente.) Dr. G. Benischke. A discussion of the construction and operation of the measuring instruments made by the Allgemeine Elektrizitäts-Gesellschaft, of Berlin. 10,000 w. Elektrotech Zeitschr—Jan. 26, 1899. No. 26074 B.

Hysteresis.

The Hysteresis Errors of Electricity Meters, Containing Soft Iron Armatures. Wilbur M. Stine. Discusses the variable potential rheostat, designed by the writer, and the method of using it in the study of this subject. 2000 w. Elec Wld—Feb. 18, 1899. No. 26141.

The Hysteresis of Iron and Steel at Ordinary Temperatures and at the Temperature of Solid Carbon Dioxide. A. H. Thiessen. Investigations of the hysteresis of iron, steel and nickel-steel, giving diagrams and tables. 1600 w. Phys Rev—Feb., 1899. No. 26180 D.

Hysteresis Meter.

The Blondel & Carpentier Hysteresis Meter. (Sur l'Hystérésimètre Construit par MM. Blondel et Carpentier.) Marcel Deprez. A communication to the French Academy in which M. Deprez shows the identity of the Blondel & Carpentier hysteresis meter with one devised by himself several years before. 1000 w. Compts Rendus—Jan. 9, 1899. No. 26010 D.

Instruments.

Commercial Instruments for Indicating and Recording Electrical Quantities, with a note on the New Aron Meter. G. S. Shoults. Condensed paper read before the Northern Society of Elec. Engs. The requirements of such instruments are considered and the accuracy attainable. Ill. 1500 w. Elec Eng, Lond—Feb. 10, 1899. No. 26110 A.

Meter.

General Meter Practice. Lyman C. Reed. On the testing of electric meters in the consumers' premises. 1800 w. Am Elect'n—Feb., 1899. No. 25830.

Resistance.

The Contact Resistance of Carbon and Copper Brushes. A short digest of an article by E. Arnold, in Elektrotechnische Zeitschrift, discussing this subject. 700 W. Elec Eng, Lond—Jan. 27, 1899. No. 25821 A.

POWER APPLICATIONS.**Agricultural.**

The Applications of Electricity to Agriculture in Germany. (L'Electrotechnie Agricole en Allemagne.) Paul Renaud. A long review of the extent to which electricity has been used in agricultural work in Germany, and a discussion of its possible progress in France and her colonies. Many devices are illustrated. 15000 w. Bull de la Societe d'Encour—Jan., 1899. No. 26020 G.

The Borsig Electric Plow. (Der Elektrische Pflug der Maschinenfabrik von A. Borsig in Berlin.) F. Brutschke. Illustrating a system of transmission from a central point to a number of fields to deliver current to cable-drawn plows operated by electric motors. 1800 w. Elektrizität—Jan. 21, 1899. No. 26081 B.

Cloth Pressing.

Cloth Pressing by Electricity. Report by Mr. Ch. Monchel, on a new process known as the "electro-calidor" process, which consists of press-

ing cloth by means of boards heated by electricity. 1000 w. U S Cons Repts, No. 357—Feb. 23, 1899. No. 26143 D.

Crane.

Electrically Operated 150-Ton Jib Crane at Newport News Shipyard. Walter A. Post. Abstract of a paper read at the meeting of the Soc. of Naval Archts. and Marine Engs. A statement as to size, capacity, range of operation, etc., with description of particular details. Ill. 3000 w. Elec Eng. N. Y.—Feb. 2, 1899. No. 25684.

Electric Locomotive.

See Railway Affairs, Motive Power.

Electric Towing.

Electric Towing upon Navigable Waterways. Reviews the various attempts that have been made to solve the problem of towing boats on canals, and illustrates and describes the system devised by M. Galliot. He uses an electric traction engine. 1800 w. Sci Am Sup—Feb. 4, 1899. No. 25699.

Exposition.

Electricity at the Paris Exposition of 1900. Georges Dary. A brilliant description of the plans which have been made for the electric lighting, traction and display at the coming exposition. 3000 w. Engineering Magazine—March, 1899. No. 26099 B.

Machine Driving.

Electric Driving at the Machine Works of the General Electric Company of Berlin. (Die Elektrische Kraftverteilung in den Maschinenbauwerkstätten der Allgemeinen Elektrizitäts-Gesellschaft, Berlin.) O. Lasche. A description of this important manufacturing establishment showing the great advantages which have been derived from the introduction of independent electric driving, for machine tools. Serial. Part I. Zeitschr d Ver Deutscher Ing—Feb. 4, 1899. No. 26066 D.

Motor.

The Modern Single-Phase Alternating-Current Motor. T. M. Meston. On the high efficiency of these machines, and the uses to which they are applied. 1500 w. Elec Wld—Feb. 4, 1899. No. 25689.

Motor Diagrams.

Induction Motor Diagrams. C. C. Hawkins. A detailed description of the graphical method, with illustrations. 1600 w. Elect'n, Lond—Jan. 27, 1899. Serial, 1st part. No. 25819 A.

Motor Installation.

Motor Installation at the Chicago "Daily News" Office. Charles A. Dresser. Read before the Chicago Elec. Assn. Describes the equipment and operation, with some comments on the improvement, and on other devices used in the press room. 3000 w. Elec, N. Y.—Feb. 22, 1899. No. 26146.

Separators.

The Magnetic Separation of Minerals. (Triage Magnétique des Minerais.) F. Schiff. A general discussion of the various methods which have been devised for the separation of minerals by the use of intense magnetic fields. 2000 w. 1 plate. Le Génie Civil—Jan. 14, 1899. No. 26000 D.

TRANSMISSION.**Transmission Line.**

A Transmission Line to Los Angeles. Illustrates and describes the installation and the service rendered. 2700 W. St Ry Rev—Feb. 15, 1899. No. 25960 C.

Traveling Platform.

The Electric Platform of the Exposition. (Plate-Forme Electrique de l'Exposition.) An illustrated description of the experimental traveling platform constructed to demonstrate the practicability of the device on a large scale. 1000 w. La Revue Technique—Jan. 25, 1899. No. 26018 D.

MARINE ENGINEERING

American Line.

American Line Ships. Story of their operation in connection with mail subsidies, as told by Clement A. Griscom. 1800 W. Marine Engng—Feb. 9, 1899. No. 25872 C.

Channel Steamers.

The Belgian Steamers of the Ostend-Dover Line. (Les Paquebots Belges de la Ligne Ostende-Douvres.) D. Bellet. A very fully illustrated account of these fine new Channel steamers; referring especially to the Princess Clementine, of 1540 tons displacement, and of more than 22 knots speed. 3500 W. La Revue Technique—Dec. 25, 1898. No. 26014 D.

Congress.

The Transactions of the VII Maritime Congress in Brussels, 1898. (Ueber die Verhandlungen des VII Schiffahrts-Congresses in Brussel, 1898.) A. Schromm. A general review of the subjects discussed, with numerous illustrations of harbor improvement works, etc. 5000 W. Zeitschr d Oesterr Ing u Arch Ver—Feb. 3, 1899. No. 26057 B.

Copper Plating.

Copper Plating Vessels. Explains the advantage of copper as a sheathing for vessels, and describes a new system of depositing the copper. Ill. 1400 W. Ir Age—Feb. 23, 1899. No. 26162.

Inland Navigation.

Inland Navigation in Europe and North America, with Special Reference to Inland Navigation in England. Leveson Francis Vernon-Harcourt. Presents the importance of solving this problem, and notes the recent interest; reviews the waterways of N. America, Germany, France and Belgium; states the conditions in England, giving conclusions. Discussion. 16500 W. Jour Soc of Arts—Jan. 30, 1899. No. 25645 A.

Merchant Marine.

Efforts to Improve the French Merchant Marine. Gives the report of the parliamentary committee appointed by the Minister of Commerce for the purpose of considering the best measures for the upbuilding of the French merchant marine. 1800 W. U S Cons Repts, No. 350—Feb. 14, 1899. No. 25878 D.

Our Merchant Marine. Sereno E. Payne. Discusses the necessity of building up the American merchant marine and the course best to adopt. 2800 W. N Am Rev—Feb., 1899. No. 25670 D.

Oceanic.

The "Oceanic," and How It Was Launched. Interesting particulars in regard to this vessel and the manner of launching, which proved so successful. Ill. 5400 W. Engr, Lond—Jan. 20, 1899. No. 25630 A.

The "Oceanic." Illustrates the vessel before and immediately after the launch, giving some particulars of interest. 1200 W. Engng—Jan. 20, 1899. No. 25612 A.

The White Star Liner "Oceanic." Illustrates and describes this large vessel, and compares it with the "Great Eastern," giving also some account of the launching. 1800 W. Sci Am—Feb. 11, 1899. No. 25861.

Ocean Routes.

Routes Adopted by the Transatlantic Steamship Lines. (Routes Adoptées par les Compagnies Transatlantiques.) A statement of the new routes going into effect January 15, 1899, with chart of the North Atlantic. 1200 W. Le Yacht—Jan. 28, 1899. No. 26034 D.

Ocean Steamers.

The Structural Features of Large Ocean Steamers. Editorial discussion of the modifications made necessary by growth in dimensions. 1700 W. Engr, Lond—Feb. 10, 1899. No. 25976 A.

Pontoon Barge.

Vessel to Carry Canal Boats. Describing a novel craft designed for the Lake Erie service

of the Cleveland Steel Canal-Boat Co. 1000 W. Marin Rev—Feb. 2, 1899. No. 25767.

Propulsion.

Discussion of the Mechanical Theory of Steamship Propulsion. Robert Mansel. The paper is a continuation of an article published in this journal on Oct. 14, 1898. Gives formula and graphical illustrations. 2500 W. Engr, Lond—Feb. 10, 1899. No. 25973 A.

Sailing Ships.

Steel vs. Wood as a Material for Sailing Ships, with Data of American Ships in Service. William A. Fairburn. Gives brief descriptions of vessels of both types, and claims the great superiority of steel over wooden vessels. Ill. Marine Engng—Feb., 1899. No. 25763 C.

Shipbuilders.

Thames Pioneer Shipbuilders and Marine Engineers. Biographical notes of some of the originators of these establishments, with photographs. 6500 W. Engr, Lond—Jan. 27, 1899. No. 25811 A.

Shipbuilding.

American Rivalry in the Ship Building Industry. Considers the conditions and causes that contribute to success in this field. 2200 W. Ir & Coal Trade Rev—Jan. 20, 1899. No. 25635 A.

The Shipbuilding Boom. Editorial on statistics given in Lloyd's Returns, with explanation of why there is a seeming disparity between Lloyd's and the published statistics given in a previous issue of this paper. 1500 W. Engng—Jan. 20, 1899. No. 25616 A.

The World's Shipbuilding in 1898. A clipping from a British journal showing the shipbuilding for the year just closed, with interesting comments. 1300 W. U S Cons Repts, No. 350—Feb. 14, 1899. No. 25879 D.

Steamer.

An Ice Breaking Steamer for Russia. A description of the powerful quadruple screw steamer Ermack, especially designed for the purpose of breaking the ice and keeping open the Northern ports of Russia. Engng—Feb. 24, 1899. No. 26370 A.

Submarine Boats.

Submarine Boats. Editorial discussion of the invention of Gustave Zede, stating its special features, and her performance as compared with other submarine boats. 1800 W. Engr, Lond—Jan. 20, 1899. No. 25633 A.

Transatlantic.

Transatlantic Passengers. Interesting statistics of the passenger traffic entering and leaving New York during the past year. 1000 W. Engng—Feb. 3, 1899. No. 25910 A.

Tug-Boat.

The Gypsum King. Illustrated description of the new steel sea-going tug-boat being built by the Burlee Dry Dock Company for the New York and Nova Scotia trade. 2300 W. Naut Gaz—Feb. 16, 1899. No. 26136.

Vibrations.

Vibrations of Steamships and Methods of Balancing Marine Engines. C. H. Peabody. Considers the cause of vibration to be due to the coincidence of the time of revolution of the engine to the natural time of vibration of the hull. 3500 W. Marine Engng—Feb., 1899. Serial. 1st part. No. 25762 C.

Yacht.

Twin-Screw Steam Yacht "Atmah." An illustrated description of the largest and most notable yacht built in Great Britain in 1898. 1300 W. Sci Am Sup—Feb. 18, 1899. No. 25942.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Autocar.

The Autocar Industry. Illustrates a pleasing and novel construction, the invention of W. J. Still, and describes its special features. Also gives late news in reference to the use of compressed air in New York. 2500 w. Can Engr—Feb., 1899. No. 25938.

Cycle Exhibition.

Automobiles at the Late Cycle Exhibition. Illustrations showing types of most of the vehicles, with brief descriptions. 1500 w. Sci Am—Feb. 18, 1899. No. 25940.

Freight Wagons.

Automotor Freight Wagons and Freight Rates in England. Stating the desire for self-propelled freight road wagons in Great Britain, and the success thus far attained. Invites American competition. 2000 w. U. S. Cons Repts, No. 338—Jan. 31, 1898. No. 25638 D.

Haulage.

Motor v. Horse Haulage. An Account of Our Nine Months' Experience. S. H. Sparkes. Read before the Liverpool Self-Propelled Traffic Assn. Gives particulars of the service of a motor-van used by Messrs. Fox Brothers & Co., owners of large woolen mills in England. 3000 w. Ind & Ir—Jan. 20, 1899. Serial. 1st part. No. 25637 A.

Oil Motor Car.

The Koch Heavy Oil Motor Car. Illustrates this motor, which is considered the most successful of heavy oil motors which has appeared, and calls attention to some features. 1200 w. Engr, Lond—Feb. 3, 1899. No. 28921 A.

Tire Problem.

Automobiles and the Tire Problem. Opinions of prominent men in the trade concerning the effect of the automobile industry on the demand for rubber. 900 w. Ind Rub Wld—Feb. 1, 1899. No. 25754 D.

HYDRAULIC ENGINEERING.

Hydrodynamics.

The Selection of a Formula for Velocity (Choix d'une Formule de Célérité.) The report of a committee of the French Academy upon the flow of water, recommending the formula of M. Boussinesq. 1500 w. Comptes Rendus—Jan. 9, 1899. No. 26011 D.

Storage.

The Influence of Storage Reservoirs upon Water Power Plants. (Einfluss der Teiche auf den Betrieb der Wassertriebwirke.) Tiegel v. Lindenkrön. An elaborate mathematical investigation of the water storage reservoir problem, using both analytical and graphical methods. 5000 w. Oesterr Monatschr f d Oeffent Bandienst—Feb., 1899. No. 26050 D.

Water-Power.

A Proposed Water-Power Improvement in the Gorge of the Niagara River. John Birkinbine. Outlines a plan for diverting a portion of the river into a canal which deliver 10000 cu. ft. per second at moderate velocity, capable of producing 35,000 h. p. Ill. 1800 w. Pro of Eng's Club of Phila.—Jan., 1899. No. 26127 D.

Water Powers in Southern California. C. G. Baldwin. Statements of the essential considerations which relate to these enterprises, discussing the causes of failure, the vital questions, and the cost of power. 4000 w. Jour of Elec—Jan., 1899. No. 26161.

Water Powers of Ontario. Thomas W. Gibson. From the report of the Ontario Bureau of Mines. An account of the vast number of waterfalls, the practical uses, with text of the act and regula-

tions which were adopted in 1898. 2800 w. Can Elec News—Feb., 1898. No. 26137.

MACHINE WORKS AND FOUNDERIES.

Automatic Machinery.

The Designing of Automatic Machinery. Hanson Robinson. Read at meeting of the Baltimore Chapter of the Assn. of Am. Draftsmen. Discusses the questions that should be considered before beginning the designing of labor-saving machines. 1700 w. Am Mach—Feb. 16, 1899. No. 25927.

Ball Bearings.

See Street and Electric Tramways.

Boring Mill.

Unusual Profile Turning on a Boring Mill. Illustrated description of a boring mill containing some unusual features, and particulars of an unusual job done on it. 900 w. Am Mach—Feb. 9, 1899. No. 25835.

Chains.

Welded Chains. E. J. Taylor. Paper read before the Manchester Assn. of Eng's. Describes the work and the testing. 2300 w. Mech Wld—Feb. 3, 1899. Serial. 1st part. No. 25896 A.

Crane.

A Petro-Automotor Crane. Illustrated description of an application of the petro-motor to work a movable crane. 1200 w. Automotor Jour—Jan., 1899. No. 25643 A.

Some Variations in Standard Crane Practice. Joseph Horner. Discusses differences in detail and workmanship, and the taste in design. 4800 w. Engng—Feb. 3, 1899. No. 25906 A.

Design.

Some Pump Problems. W. H. Booth. Reports some of the writer's investigations in connection with the design of artesian pumps. 2000 w. Am Mach—Feb. 2, 1899. No. 25700.

Dies.

Die Construction. George B. Painter. Illustrated description of a combination shearing, piercing, bending and forming die, applicable to a large variety of press work. 800 w. Am Mach—Feb. 23, 1899. No. 26159.

Fits.

Shrink and Force Bits. Jno. J. Wilmore. Reports experiments made by students in mechanical engineering, giving results and conclusions. Ill. 1400 w. Am Mach—Feb. 16, 1899. No. 25929.

Heavy Castings.

Casting a Harris-Corliss Engine Bed. R. H. Palmer. Illustrates and describes a cast for a 32-inch engine, weighing about 23,000 pounds. 1700 w. Am Mach—Feb. 16, 1899. No. 25928.

Instruments.

Measuring and Testing Instruments Used in the Manufacture of Naval Ordnance. E. J. Prindle. Illustrates and describes the instruments, the use of which makes possible the high degree of precision required. 3500 w. Sci Am—Feb. 25, 1899. No. 26154.

Jacks.

Hydraulic Jacks for Lifting Iron Bridges. (Hydraulische Vorrichtungen zum Heben von Eisernen Eisenbahnbrücken.) With illustrations of the powerful hydraulic jacks used in lifting the iron bridge near Dordrecht in Holland. 1800 w. Glaser's Annalen—Feb. 1, 1899. No. 26047 D.

Machine Tool.

Boring, Threading and Countersinking Machine. From *Revue Industrielle*. Illustrated detailed description. 1500 w. Sci Am Sup—Feb. 11, 1899. No. 25864.

Molding.

Molding Cast Iron Columns. John S. Knoeppel. Gives points helpful to young molders. Ill. 1100 w. Foundry—Feb., 1899. No. 26130.

Rifling.

Rifling a Big Navy Gun. Edwin J. Prindle. Illustrates and describes the manner in which it is performed at the Naval Gun Factory at Washington, D. C. 900 w. Am Mach—Feb. 16, 1899. No. 25930.

Roller Bearing.

The Hyatt Roller Bearing. Report of the Committee on Science and the Arts, on the invention of J. W. Hyatt. Illustrates and describes the invention and reports experiments made, giving tabulated comparisons. 1200 w. Jour Fr Inst—Feb., 1899. No. 25776 D.

Shop Costs.

Machine Tool Depreciation as an Element of Manufacturing Cost. H. M. Norris. Discussing the practice of various establishments, and suggesting a solution of the problem from the author's experience, with forms and tables. 4500 w. Engineering Magazine—March, 1899. No. 26096 B.

Shop Practice.

Some Points of Practice from a Manchester Shop. F. J. M. The points illustrated and described were gathered from the establishment of Hans Renold, of Manchester, Eng. The principal business is the manufacture of transmission chains. 2500 w. Am Mach—Feb. 23, 1899. No. 26158.

Spraying.

Blackening Dry Sand Molds with Compressed Air. I. B. Thomas. Illustrates and describes the construction and operation of the apparatus used. 500 w. Foundry—Feb., 1899. No. 26129.

Tubing.

The Production of Tubes and Rods by Means of Hydraulic Presses. (Die Erzeugung von Rohren und Stangen Mittels Hydraulischer Presse.) Otto Weiss. A paper before the German Society of Mechanical Engineers describing Dick's process of forming tubes of various sections from ductile metals. 4000 w. Glasers Annalen—Jan. 15, 1899. No. 26044 D.

Wood-Working Machinery.

The Development of Wood-Working Machinery. John Richards. Mr. Richards's second paper is devoted to the evolution of American log-sawing machines, from the small circular mill to the great band log-mills used on the enormous red-wood logs of the Pacific coast. 4500 w. Engineering Magazine—March, 1899. No. 26094 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. Mr. Orcutt's third paper deals mainly with the effects of environment on the efficiency of workmen, comparing the conditions under which mechanics live in Europe and America. 5000 w. Engineering Magazine—March, 1899. No. 26093 B.

On Works' Organization. Tom Westgarth. Paper read at a meeting of the Northeast Coast Inst. of Engs. and Shipbuilders. Suggestions intended for marine engineers, but applicable to any large works. 2000 w. Steamship—Feb., 1899. No. 25884 A.

MATERIALS OF CONSTRUCTION.**Resistance.**

The Resistance of Tension Rods of Given Section to Shock. (Einiges über die Stossfestigkeit von Zugstangen Abgesetzten Querschnittes.) G. Stockhammer. Showing how the resistance to shock may, under certain conditions, be increased by a reduction of section. 200 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 27, 1899. No. 26056 B.

Specifications.

Standard Specifications for Steel. W. R. Webster. A discussion of the fairest specification requirements from the standpoint of the trained inspector, taking into account chemical composition, conditions of working, and effect of temperature. 4500 w. Engineering Magazine—March, 1899. No. 26095 B.

Testing.

Improved Devices for Testing Metals. (Appareils Nouveaux pour l'Essai des Métaux.) Ch. Fremont. Describing the application of recording devices to machines for testing the resistance to tension, punching and shearing, as well as drop tests. Photo-micrography is also discussed. 3000 w. Soc Ing Civ de France—Dec., 1898. No. 26027 F.

The Mechanical Testing of Metals. (Essais Mécaniques des Métaux.) Georges Charpy. The beginning of a treatise on testing of materials. The first portion consists of a description of the principal varieties of testing machines. Serial. Part I. 10000 w. Revue de Mécanique—Jan., 1899. No. 26024 H.

POWER AND TRANSMISSION.**Compressed Air.**

Advantages of Compressed Air over Other Sources of Power in Deep Mining—Great Developments Predicted. R. P. Whitelaw. Read before the Mech. Engs' Assn. of S. Africa. Suggestions regarding the suction-valve chamber; how intercooling might be improved, etc. 4000 w. Compressed Air—Feb., 1899. No. 25676.

Driving Pumps by Compressed Air. William Cox. Explains how to determine in a simple manner the number of cubic feet of free air at a certain pressure necessary to pump a given quantity of water to a required height. Also means of ascertaining power cost, and other desirable information. 2000 w. Compressed Air—Feb., 1899. No. 25677.

Liquefied Gases.

Liquefied Gases and Air in the Industries. Ernesto Mancini. A review of experimental progress in this field, and the uses to which the gases have been or may be applied. 3800 w. Chau—Feb., 1899. No. 25602 C.

Lubrication.

Oil Used for Lubrication. Discusses various lubricants and calls attention to some practical methods of testing oils and oil mixtures. 3000 w. Mach, Lond—Jan. 15, 1899. No. 25646 A.

Machinery Driving.

See Electrical Engineering, Power Applications.

Ropes.

Rope Testing. George A. McCarthy and Ernest G. Matheson. Read before the Applied Science Graduates' Society of McGill Univ. Gives a brief account of the method of manufacturing ordinary ropes, and describes the testing of ropes as carried out in the laboratory. 1600 w. Can Engr—Feb., 1899. Serial. 1st part. No. 25937.

Tension.

Centrifugal Tension in Ropes and Belts. C. N. P. A reply to statements made by G. H. Kenyon, in a recent lecture on "Ropes and Rope Driving," with explanation of the writer's views. Ill. 1800 w. Mech Wld—Jan. 20, 1899. No. 25647 A.

SPECIAL MOTORS.**Air Motor.**

The Hoadley Knight Compressed Air Motor. An illustrated description of the motor and its operation. 1000 w. Sci Am—Feb. 4, 1899. No. 25695.

Diesel.

Diesel's Rational Heat Motor. E. D. Meier. Reviews work in connection with steam, and conclusions that led to a renewal of interest in

the internal combustion engines, and the great advance made by Rudolf Diesel, describing his invention and its working. Ill. 6500 w. Sib Jour of Engng—Feb., 1899. No. 26177 C.

Notes on the Diesel Heat Motor. (Mitteilungen über den Dieselschen Wärmemotor.) R. Diesel. With a number of illustrations of recently constructed motors, and data of experiments with a variety of liquid fuels. 2 articles. 5000 w. Zeitschr d Ver Deutscher Ing—Jan. 14, Feb. 4, 1899. No. 26061 each D.

Gasoline Engines.

Tests of Gasoline Engines in Pumping Plants. Gives the results of a number of tests by J. W. Ledoux. 500 w. Eng Rec—Feb. 11, 1899. No. 25853.

Gas Power.

Gas Power. J. E. Dowson. Some interesting particulars relating to gas engines, and practical results of working them with generator gas. 2500 w. Gas Eng's Mag—Jan. 10, 1899. No. 25729 A.

The Riché Gas Process. (Le Gaz Riché.) A. Rainville. An account of the use of gas produced from the distillation of wood as a fuel for gas engines. The wood is distilled in closed retorts, furnishing a high grade of charcoal, and the gas gives more power in a gas engine than illuminating gas. 2000 w. L'Electricien—Jan. 28, 1899. No. 26037 B.

The Utilization of Blast-Furnace Gases. Editorial review of what has been already accomplished, considering the future outlook encouraging. 1500 w. Engr, Lond—Feb. 10, 1899. No. 25977 A.

STEAM ENGINEERING.

Air Pump.

Performance of a Vertical Air Pump without a Foot Valve. (Wirkungsweise einer Stehenden Kondensation-Luftpumpe ohne Saugventile.) H. Berg. A description and analysis of action of an improved form of air pump for use with condensing steam engines; the foot-valve is dispensed with, and a high efficiency maintained. 3500 w. Zeitschr d Ver Deutscher Ing—Jan. 28, 1899. No. 26064 D.

Boiler Coverings.

Tests of Locomotive Boiler Coverings. Abstracted from a paper by Robert Quayle, presented at the January meeting of the Western Ry. Club, giving a report of tests made on the branch line of the Chicago & Northwestern. 3300 w. R R Gaz—Feb. 17, 1899. No. 25947.

Boiler Explosion.

Barking Boiler Explosion. Reports important evidence given at the inquest. 4000 w. Engng—Jan. 20, 1899. No. 25617 A.

Boiler Explosion at Eccles. Gives briefly the construction and history of the boiler, with report of the investigation. 4000 w. Engng—Jan. 20, 1899. No. 25618 A.

Boilers.

Designing Boilers for a Small Street Railway Plant. William Kent. Part first considers the preliminary studies peculiar to the service required. 1600 w. St Ry Rev—Feb. 15, 1899. Serial. 1st part. No. 25963 C.

The Care of Steam Boilers. An abstract of the rules of the National Boiler and General Insurance Co., of Manchester, England. 3000 w. Eng Rec—Feb. 11, 1899. Serial. 1st part. No. 25851.

Calorimeters.

Combustion and Calorimeters. H. J. Williams. Extracts from a paper presented at the December meeting of the New England R. R. Club. Shows the importance of ascertaining the heating power of coals, and describes various calorimeters, stating their defects and advantages. 2800 w. R R Gaz—Feb. 17, 1899. No. 25952.

Coal Calorimetry.

Berthier Method of Coal Calorimetry. Charles V. Kerr. Describes this method of finding the

heating power of fuels. Its practical convenience is claimed. 2500 w. Jour W Soc of Eng's—Dec., 1898. No. 25673 D.

Calculating the Calorific Power of Coal from Analytical Data. D. De Paepe. *Bulletin Assn. Belge des Chimistes*. Explains the writer's method of determining the calorific power, and the conclusions reached. 700 w. Col. Guard—Jan. 27, 1899. No. 25799 A.

Coal Efficiency.

The Increased Efficiency of Coal. On the importance of getting as much motive power out of every pound of coal, indicating what has been done and what remains to be done. 1600 w. Col Guard—Jan. 20, 1899. No. 25623 A.

Compression.

The Compression of Steam in the Clearance Space. (La Compression de la Vapeur dans l'Espace Mort.) L. Anspach. A general review of the discussion between Professors Dwelshauvers-Dery and Boulvin, showing the correctness of the conclusions of the former, but urging the necessity of further experiments. 7500 w. Revue de Mécanique—Jan., 1899. No. 26023 H.

Condensing.

Central Condensers. (Centralcondensation.) Chr. Eberle. A discussion of the construction and use of a main condensing apparatus for the reception of the exhaust steam from a number of engines, with examples from existing plants. Serial. Part I. 3500 w. Stahl und Eisen—Feb. 1, 1899. No. 26041 D.

Condensers and Air Pumps. Illustrates and describes some of the salient features in the design and construction of a condensing plant. 2200 w. Prac Engr—Feb. 10, 1899. Serial. 1st part. No. 26107 A.

Water-Cooling, as Applied to Condensing. Horace W. Jarvis. Abstract of paper read at Middlesbrough meeting of the Cleveland Inst. of Eng's. Remarks on how much condensing saves, with descriptions of various forms of coolers. Short discussion is given. 2000 w. Col Guard—Jan. 20, 1899. No. 25622 A.

Firing.

Plain Talks to the Boys. C. B. Conger. A talk on the subject of firing coal properly, confined principally to the practical and mechanical side. 2400 w. Loc Engng—Feb., 1899. No. 25791 C.

Flue Gases.

The Rapid Testing of Gases from Industrial Furnaces. (Sur l'Essai Rapide des Fumées dans des Foyers Industriel.) H. Le Chatelier. A description of a simple apparatus employing the principle of the changes in color of heated copper. 1000 w. Bull de la Societe d'Encour—Jan., 1899. No. 26021 G.

Fuel.

Burning Low-Priced Fuel. W. H. Wakeman. Points out objections to the use of culm or fine coal. 500 w. Am Mach—Feb. 9, 1899. No. 25834.

Liquid Fuel. A discussion of the advantages and disadvantages in connection with liquid fuel. A comparison of cost, with a description of Urquhart's pulverizer, as given in London Engineering, and related matter of interest concerning methods used in various countries. 4500 w. Locomotive—Dec., 1898. No. 25658.

Fuel Cost.

See Economics and Industry, Miscellany.

Governors.

The Controlling Power of Governors. (Die Stellkraft von Regulatoren.) F. J. Weiss. A mathematical examination of the relations of the forces in centrifugal governors, with especial regard to the power available for the regulating mechanism. 3000 w. Zeitschr d Ver Deutscher Ing—Jan. 21, 1899. No. 26062 D.

Hoisting Engines.

The Torque of Hoisting Engines. D. S. Kimball. Discusses the operations of hoisting en-

gines in mining, and the means of determining the torque. 1300 w. *Sib Jour of Engng*—Feb., 1899. No. 26176 C.

Indicator Springs.

Testing Indicator Springs. L. G. F. A description of several types of apparatus that have been used for testing indicator springs, both in this country and in Europe. Ill. 5000 w. *Mach*, N. Y.—Feb., 1899. No. 25722.

Mechanical Stokers.

Test of an American Stoker. Reviews a test made by G. H. Barrus on a plant in a cotton-mill at Lowell, Mass. 800 w. *Eng Rec*—Feb. 25, 1899. No. 26190.

Pyrometer.

Pneumatic Pyrometer and Gas Composimeter. Illustrated description of an instrument for indicating and recording furnace temperatures. Also a gas composimeter which indicates and records the composition of gases of combustion. 1500 w. *Am Mach*—Feb. 2, 1899. No. 25702.

Rotary Engine.

A Two-Piston Rotary Engine, with Variable Cut-Off. Illustrates and describes the construction and principle of operation of a novel engine. 1300 w. *Am Mach*—Feb. 2, 1899. No. 25701.

Smoke.

Apparatus for Consuming Smoke. From *La Nature*. A decree awarding prizes for the best smoke-consuming devices, in France, in the year 1894 brought numerous projects, and thirty were selected for study. Experiments were made, and the awards assigned. The article describes the apparatus of successful competitors. 2000 w. *Sci Am Sup*—Feb. 25, 1899. Serial. 1st part. No. 26157.

Steam Consumption.

Consumption of Steam by Warship Auxiliary Machinery. A Few Figures. F. W. Roller. Reports a careful investigation of the steam consumption of the auxiliary machinery in common use on the U. S. S. *Nashville*. 1300 w. *Am Elect'n*—Feb., 1899. No. 25829.

Economy of Steam Production. A. L. Harrison. Describes a flour mill plant in the central West, and the means of securing economy. 1300 w. *Am Elect'n*—Feb., 1899. No. 25832.

Theory.

A Defense of the Practical Theory of the Steam Engine. (*Défense de la Théorie Pratique de la Machine à Vapeur*.) V. Dwelshauvers-Dery. A general examination of the analysis of Hirn, as sustaining the author's experiments on the wastefulness of compression. 6000 w. *Revue de Mécanique*—Jan., 1899. No. 26022 H.

Water Gages.

Concerning Water Gages. W. H. Wakeman. Some suggestions relating to the use of the combination water column. 800 w. *Am Mach*—Feb. 23, 1899. No. 26160.

Water Softening.

Water-Softening Plants. On the advantages and process of water softening, the cost, the most approved method, and illustrations of the plant at the Wayne Knitting Mills of Fort Wayne, Ind. 2200 w. *Eng & Min Jour*—Feb. 4, 1899. No. 25787.

Water-Tube.

Some Advantages of Water-Tube Marine Boilers. George R. Bale. States the good features of these boilers and the advantages which have led to their almost exclusive adoption in warships, and their probable adoption by the merchant-marine. 3500 w. *Prac Engr*—Feb. 3, 1899. No. 25901 A.

MISCELLANY.

Aerodynamics.

The Aerodynamic Conditions of a Thin Plate. (*Der Aerodynamische Schwebezustand einer Dünnen Platte*.) Josef Popper. A critical discussion of the theory of v. Loessl concerning the conditions of soaring or floating of a thin plate in the air. Two papers. 8000 w. *Zeitschr d Oesterr Ing u Arch Ver*—Jan. 27, Feb. 3, 1899. No. 26055 each B.

Bending.

The Bending of Wood. (*Le Cintrage des Bois*.) A description of the apparatus for steaming and bending wood used in the works of the Eastern Railway of France at Romilly-sur-Seine. 4000 w. 2 plates. *Rev Gen des Chem de Fer*—Jan., 1899. No. 26031 F.

Engineering Practice.

The Application of the Science of Mechanics to Engineering Practice. Abstract of lecture by Prof. Barr, before a special meeting of the students of the Inst. of Civ. Eng., London. A general talk on the subject. 2000 w. *Prac Engr*—Feb. 10, 1899. No. 26108 A.

Handling.

Storage and Handling Devices for Material in Bulk. (*Lager und Transportanlagen für Masengüter*.) M. Buhle. A discussion of the various forms of conveyors, elevators, and similar devices for handling grain, coal and similar articles, especially in connection with harbor warehouses and storage buildings. Serial. Part I. *Zeitschr d Ver Deutscher Ing*—Jan. 28, 1899. No. 26063 D.

Refrigeration.

A Refrigerating Plant on the Pictet System. (*Kälteerzeugungsanlage nach System Pictet*.) W. Brautigam. An illustrated description of a large refrigerating plant on the Pictet system, with data and results of tests. 3500 w. *Zeitschr d ver Deutscher Ing*—Feb. 4, 1899. No. 26067 D.

The Refrigerating Plant of Val-de-Grâce. (*Les Installations Frigorifiques du Val-de-Grâce*.) An illustrated account of the refrigerating apparatus used for preservation of bodies awaiting identification, as used in several Paris hospitals, as well as at the morgue. 1200 w. *Le Genie Civil*—Jan. 21, 1899. No. 26002 D.

MILITARY ENGINEERING

Armor.

The Nickel Steel Armor Patents. Gives facts of a notable case recently decided by the President, with the basis for the decision. 2400 w. *Ir Age*—Feb. 9, 1899. No. 25867.

Artillery.

Rapid-Fire Mountain Gun of the Mexican Army. (*Le Canon de Montagne à Tir Rapide de l'Armée Mexicaine*.) F. Schiff. An illustrated description of the Mondragon system of light rapid-fire mountain artillery, as constructed

by the St. Chamond works. Photographs and detailed drawings are given. 2000 w. 1 plate. *Le Genie Civil*—Jan. 28, 1899. No. 26005 D.

Battleships.

A Representative Battleship and Coast Defense Vessel of the French Navy. Illustrates and describes two important types of vessels designed by French naval architects. 1300 w. *Sci Am Sup*—Feb. 4, 1899. No. 25696.

Battleships and Monitors Now Building for the Navy. Illustrates and describes the eight

battleships and four monitors in process of construction. 1900 w. *Sci Am*—Feb. 25, 1899. No. 26156.

Repairing the Keel of a Battleship. Illustrated account of the repairs to the "Massachusetts," being carried on at the Brooklyn Navy Yard. 1000 w. *Sci Am*—Feb. 18., 1899. No. 25941.

Defences.

Our Coast Defences. On the coast defences of the United Kingdom, describing some recent work and criticising the patchwork character. Ill. 1500 w. *Engr*, Lond—Jan. 20, 1899. No. 25628 A.

Destroyer.

Fastest in the World. Illustrates and briefly describes the Chinese torpedo-boat destroyer *Hai Lung*, which holds the speed record of the world, attaining 36.7 knots. 700 w. *Marine Rev*—Feb. 2, 1899. No. 25766.

U. S. S. *Stringham*, Torpedo-Boat Destroyer under Construction at Wilmington, Del. Illustrates and describes this boat, now being constructed at Wilmington, Del., noting its novel features. 1000 w. *Marine Engng*—Feb., 1899. No. 25764 C.

Explosives.

Experiments with High Explosives in Large Guns. Hiram Stevens Maxim. An account of experimental investigations and their results. 4800 w. *N Am Rev*—Feb., 1899. No. 25668 D.

High Explosives in Guns and Shells. From Captain O'Neil's monograph upon the construction of guns and shells for the firing of high explosives, covering about all the experiments recently made in this country and abroad, and discussing especially the Gathmann system. 4500 w. *Ir Age*—Feb. 23, 1899. No. 26163.

France.

The Navy and New Construction at the Close of 1898. (*La Marine et les Constructions*

Neuves a la Fin de 1898.) A review of the state of the French navy and the progress of the work now in course of construction. 2000 w. *Le Yacht*—Jan. 7, 1899. No. 26032 D.

Naval Engineers.

The Duties of Naval Engineers. The first of a series of articles giving a synopsis of their life on board ships of war. The present issue deals with the responsibility of the chief engineer, and the senior engineer. 2000 w. *Engr*, Lond—Feb. 10, 1899. Serial. 1st part. No. 25972 A.

Naval Experience.

Readings from Experiences in Naval Engineering. Commodore G. W. Melville. Commodore Melville's second paper deals mainly with the changed requirements due to increasing power, speed and economy, and gives important lessons learned during the late war. 4000 w. *Engineering Magazine*—March, 1899. No. 26090 B.

Naval Risk.

The Respective Risks of France and England. (*Les Risques Respectifs de la France et de l'Angleterre*.) V. Guillox. A study of the comparative weakness of the two countries in case of war. It is maintained that the vulnerability of England's merchant marine overbalances her preponderance in naval strength. 2000 w. *Le Yacht*—Jan. 14, 1899. No. 26033 D.

U. S. Navy.

Machinery in the United States Navy. Illustrations and specifications for the main engines of the new battleships Nos. 10, 11, and 12, as taken from Commodore Melville's report. Also editorial. 2500 w. *Engr*, Lond—Feb. 3, 1899. No. 25920 A.

Steam Engineering in the United States Navy. Editorial review of the annual report of Commodore George W. Melville. 1800 w. *Engr*, Lond—Jan. 27, 1899. No. 25813 A.

MINING AND METALLURGY

COAL AND COKE.

Air Crossings.

Air Crossings or Bridges. Gives their history, describes undercasts and overcasts, and discusses which is to be preferred and when. 1500 w. *Mines & Min*—Feb., 1899. No. 25737 C.

Coal Calorimetry.

See Mechanical Engineering, Steam Engineering.

Coalfield.

The Douglas Coalfield, Lanarkshire. Robert Weir. Abstract of a paper presented at meeting of the Mining Inst. of Scotland. The location is given, the deposits described, and the working conditions discussed. 1500 w. *Col Guard*—Feb. 10, 1899. No. 25989 A.

Coal Formation.

Side-Light upon Coal Formation. W. S. Gresley. A discussion of characteristics of plants which form the coal beds, and the manner in which they were deposited. 4000 w. *Am Geol*—Feb., 1899. No. 25885 D.

Coal Jigs.

The Oberegger System of Double-Acting Coal Jigs, with Reciprocating and Oscillating Piston. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrated description, with some of their advantages. 2000 w. *Mines & Min*—Feb., 1899. No. 25739 C.

Coal Mine.

A California Coal Mine. R. H. Norton. Brief account of the mine at Tesla. 800 w. *Eng & Min Jour*—Feb. 4, 1899. No. 25788.

Coal Washing.

Coal Efficiency and Coal Washing. On the improvement effected in the constituents of the coal and its general character by washing. 1000 w. *Col Guard*—Feb. 10, 1899. No. 25988 A.

Coal Working.

Various Methods of Winning Coal in the Dortmund District. From a communication to *Glückauf* by Bergassessor Trainer. Observations on the various systems of working, and the terms used to distinguish them. Ill. 3300 w. *Col Guard*—Jan. 27, 1899. No. 25801 A.

Coal Valuation.

The Valuation of Coals. N. W. Lord. Presented before the Am. Assn. for the Adv. of Science. Discusses a number of unpublished tests and analytical results, which have been collected from various sources. 3500 w. *Eng News*—Feb. 16, 1899. No. 25966.

Coke.

The Requirements of a Good Coke. Information from an article by O. Simmersbach, published in the *Revue des Mines de Liege*. The constituents are considered in detail. 1800 w. *Ir & Coal Trds Rev*—Jan. 27, 1899. No. 25806 A.

Colliery.

Warora Colliery. An account of the working of this colliery during the year 1897-98. 700 w. *Ind Engng*—Jan. 14, 1899. No. 25994 D.

Fuel.

See Mechanical Engineering, Steam Engineering.

Gob Fires.

The Origin of Gob Fires. H. Stokes. Abstract of address delivered at Mansfield, England. Explains the new theory that the combustion is brought about by the physico-chemical actions and reactions of gases, liquids, and solids in old gobs. 900 w. Col Guard—Jan. 27, 1899. No. 25805 A.

Water and Coal Dust v. Water and Spontaneous Combustion (Gob Fire). James Ashworth. A discussion of the advisability of treating with water, mines subject to spontaneous combustion, showing that the treatment is the worst possible, and discussing the safest treatment. 2800 w. Col Guard—Feb. 10, 1899. No. 25987 A.

Jigging.

The Use of Jigging Machines in Wet Separation Processes. Walter J. May. The importance of sizing in all jigging operations, the amount of grinding necessary and other things needed to make jigging satisfactory. 1300 w. Col. Guard—Jan. 27, 1899. No. 25804 A.

Rating.

The Rating of Coal Mines. Edward Boyle. Read at meeting of the Surveyors' Inst., London. Discusses the methods used in England to arrive at a ratable value of a colliery. 4800 w. Col Guard—Jan. 27, 1899. No. 25803 A.

Roof Pressure.

Location of Roof Pressure in Longwall Working. The conditions which determine whether or not the system is practicable. 1800 w. Mines & Min—Feb., 1899. No. 25738 C.

Spain.

Coal Production in Spain. Statistics for the past year, giving an idea of the condition of the mining industry in 1898. 400 w. Col Guard—Feb. 10, 1899. No. 25985 A.

Venezuela.

Lease of Coal Mines in Venezuela. Translated copy of a contract between the Government of Venezuela and an Italian firm, providing for the working of the Guanta coal mines. 900 w. U. S. Cons Repts, No. 345—Feb. 8, 1899. No. 25768 D.

COPPER.**Idaho.**

The Copper Deposits of the "Seven Devils," Idaho. Waldemar Lindgren. The location, mining operations, topography, geology, mineral deposits, etc., are considered. 1800 w. Min & Sci Pr—Feb. 4, 1899. No. 25869.

Washington.

A Washington Copper Deposit. R. H. Norton. Illustrated description of a large deposit in the State of Washington. 900 w. Eng & Min Jour—Feb. 11, 1899. No. 25854.

GOLD AND SILVER.**Arrastra.**

How to Build and Operate an Arrastra. William H. Washburn. Gives drawings of a typical arrastra in Oregon, with description. Also particulars of other similar work. 3000 w. Min & Sci Pr—Jan. 28, 1899. No. 25715.

Assaying.

The Assay of By-Products. H. F. Loftis. Discusses the question of pot assays and scorification assays with the view of drawing out a discussion of the best general method. 1800 w. Jour of Chem & Met Soc of S. Africa—Dec., 1898. No. 25759 E.

British Columbia.

The Cassiar District, British Columbia. From report on Cassiar Central Railway Mining Land Grant, by Edward D. Self. Describes this region, the geology, the discovery of gold, etc. Maps. 2500 w. Eng & Min Jour—Feb. 18, 1899. No. 26135.

Concentration.

Concentration and Treatment of Low Grade Ores. Edmund B. Kirby. The problems involved and history of the process. Discussing the advantages and disadvantages of the German, the Missouri, the Lake Superior, and the Stamp mill systems. 6000 w. Mines & Min—Feb., 1899. No. 25736 C.

Cripple Creek.

The Mining Investor's Map of Cripple Creek Mining District, Fremont and El Paso Counties, Colorado. Compiled from records of the U. S. Surveyor General and other authentic sources of information issued by the Colorado Springs Gazette Publishing Co. Min Invest—Feb. 6, 1899. No. 25871.

Cyanide.

Cyaniding at Bingham, Utah. An account of the recovery of gold from an acid solution at the Old Jordan Mill, taken from notes of A. F. Holden, under whose direction this success was achieved. 1000 w. Eng & Min Jour—Jan. 28, 1899. No. 25603.

Cyaniding Base Ores. Matt. W. Alderson. The treatment of the base ores at Cripple Creek is described, and the subject generally discussed. 1400 w. Min & Sci Pr—Feb. 4, 1899. No. 25870.

Some Modifications of the Cyanide Process. Brief abstracts of descriptions of modifications proposed by European workers. The Pape-Henneberg and G e pner-Diehl combination process, and the Netto process. 1700 w. Min & Sci Pr—Jan. 28, 1899. No. 25714.

The Latest Cyanide Plant in the Transvaal. A description of the Henry Nourse Gold Mining Company's plant, in the Witwatersrand District, which shows the latest improvements in the treatment of tailings. 1600 w. Eng & Min Jour—Feb. 25, 1899. No. 26193.

Gold Fields.

Central Idaho Gold Field. Don Maguire. Describes a strange and comparatively unknown region, which promises rich returns. 3000 w. Mines & Min—Feb., 1899. No. 25734 C.

The Geology and Archaeology of the California Gold Fields. W. J. McGee and W. H. Holmes. Abstract of a paper read at meeting of the Geol. Soc. of America. Describes the geological changes that appear to have taken place, and the fossils and relics found. 1000 w. Sci Am Sup—Feb. 4, 1899. No. 25697.

High Mines.

Some High Mines of Telluride, Colorado. Illustrations, with brief account of the mines of Savage Basin and Silver Pick Basin. 500 w. Min & Sci Pr—Jan. 28, 1899. No. 25716.

Montana.

The Cedar Creek Placers, Montana. Fred D. Smith. The location and working of these placers. Ill. 1200 w. Eng & Min Jour—Feb. 4, 1899. No. 25786.

Nova Scotia.

The Dufferin. Particulars of this interesting mine, giving its history and many illustrations of its plant. 5800 w. Can Min Rev—Jan. 31, 1899. No. 25718 B.

Placer Mining.

Placer Mining in California. Arthur Lakes. The condition of the industry at present and an account of its former greatness. 2800 w. Mines & Min—Feb., 1899. No. 25735 C.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. Continued discussion of this paper. 5000 w. Jour of Chem & Met Soc of S. Africa—Dec., 1898. No. 25761 E.

Rhodesia.

Rhodesia and Its Mines in 1898. William Fischer Wilkinson. An account of the prospects of the gold mines of South Africa, containing much interesting information. Ill. 8500 w. Jour Soc of Arts—Feb. 3, 1899. No. 25897 A.

Roasting Furnace.

The Herreshoff Roasting Furnace. Peter S. Gilchrist. Illustrated description and statement of advantages claimed. 1300 w. *Mod Mach*—Feb., 1899. No. 25889.

Slimes.

The "Electro-Zinc" Process, and experimental Researches Which Led to Its Development. W. Battel. Describes experimental work and the writer's method of precipitating gold and silver by the "electro-zinc" process. 1500 w. *Min & Sci Pr*—Feb. 18, 1899. Serial. 1st part. No. 26173.

Sulphide Ores.

The Oxidizing of Sulphide Ores. C. Woodman. General remarks on recent advances in gold mining and extraction, with an account of the Koneman process. 2400 w. *Aust Min Stand*—Dec. 29, 1898. Serial. 1st part. No. 25653 B.

IRON AND STEEL.**Blast Furnaces.**

Plast Furnace Management. F. Louis Grammer. Concerning officers and their duties, and some practical points in regard to furnace work. 5700 w. *Mines & Min*—Feb., 1899. No. 25740 C.

The Evolution of the Blast-Furnace. A. H. Sexton. Abstract of a paper communicated to the Philosophical Society of Glasgow. Historical review of progress. 2000 w. *Col Guard*—Feb. 3, 1899. No. 25915 A.

Cupola Melting.

Blast in Cupola Meltings. Dr. Edward Kirk. From a new work on Cupola Practice, now in press. Considers the means which have been devised for supplying the required amount of air. 2300 w. *Ir Trd Rev*—Feb. 9, 1899. No. 25865.

Melting Iron in the Cupola. Edward Kirk. From a forthcoming work on Cupola Practice. Gives a case of bad melting and the cause and remedy. 2500 w. *Ir Trd Rev*—Feb. 16, 1899. No. 26138.

Iron Making.

The "Art" of Iron Making in 1750. A copy of old engravings and letter press, illustrating and describing the methods employed about the middle of the last century. 1800 w. *Ir & St Trds Jour*—Jan. 28, 1899. 1st part. No. 25883 A.

Iron Silicides.

The Commercial Manufacture of Iron Silicides. G. de Chalmot. Abstract of a paper in the *Am Jour of Chemistry*. Deals with silicides containing 25 to 50 per cent. of silicon. 1200 w. *Eng & Min Jour*—Feb. 18, 1899. No. 26134.

Malleable Iron.

Development of the Malleable Iron Industry in the United States. George C. Davis. Gives an historical account of this industry since 1835. 3400 w. *Ir Trd Rev*—Feb. 9, 1899. No. 25866.

Malleable Cast Iron. Erastus C. Wheeler. Deals with the effects of impurities found in pig iron. 4000 w. *Ir Age*—Feb. 16, 1899. Serial. 1st part. No. 25932.

Patents.

See Economics and Industry, Gov. Control.

Steels.

Special Nickel, Chromium, and Silicon Steels. A. Abraham. Abstract from the *Annales des Mines*. Relates the success attained in the use of nickel steel for armor plates, and the tests made, the use of nickel in the manufacture of gun steel, and considers high nickel steels and nickel-chromium steels. 4000 w. *Ir Age*—Feb. 2, 1899. No. 25691.

Sweden.

The Swedish-Norwegian Lulea-Ofoten Railway. (Die Schwedisch-Norwegische Unionsbahn Lulea-Ofoten.) Especially devoted to the development of the Swedish iron ore districts, with photographs and colored map. Serial. Part I. *Stahl und Eisen*—Jan. 15, 1899. No. 26040 D.

MINING.**Belgium.**

The Operation of the Mines of Belgium. (De l'Exploitation des Mines en Belgique.) H. Kuborn. A review of the Belgian mines, with especial reference to the conditions of health and safety of the employees. Tables of data are given from 1850 to the present time. 4500 w. *La Revue Technique*—Jan. 25, 1899. No. 26019 D.

China.

Mining and Railway Companies in China. Comments on the seeming chaos prevailing, and discusses the new regulations which have been preferred by the Tsung-li-Yamen, for regulating railway and mining enterprises. 1700 w. *Engng*—Feb. 3, 1899. No. 25911 A.

Regulations for Mines and Railways in China. Translation of the regulations prepared by the bureau of control for mines and railways. 1400 w. *U. S. Cons Repts*, No. 355—Feb. 20, 1899. No. 25980 D.

East Africa.

Mining and Geological Conditions in German East-Africa. (Die Bergmannischen und Geologischen Verhältnisse in Deutsch Ost-Afrika.) A report by Assessor Bornhardt, showing that the mineral resources of the country, so far as can be determined at present, are insignificant. 2500 w. *Glückauf*—Jan. 28, 1899. No. 26085 B.

Metallurgy.

Notes on Experimental Metallurgy. J. E. Clennel. An account of experimental methods used in America. 4300 w. *Jour of Chem & Met Soc of S. Africa*—Dec., 1898. No. 25760 E.

Mine Development.

Some Needed Aids to Development of Mines. John W. Gray. Thinks the things most needed are cheap power, easy and economical transportation and low reduction charges, and the education and training of the worker. 1700 w. *Min & Sci Pr*—Jan. 28, 1899. No. 25713.

Mine Ventilation.

Root Principles of Mine Ventilation. Deals with the nature of theory and the atomic theory. 6300 w. *Col Guard*—Jan. 27, 1899. Serial. 1st part. No. 25798 A.

Root Principles of Mine Ventilation. A study of the general theory of force. 5300 w. *Col Guard*—Feb. 10, 1899. No. 25986 A.

Should Mine Ventilation Be Positive or Negative? Extract from a work by Mr. Haton de la Goupilliere. Discusses the advantages and disadvantages of pressure and exhaust fans. 1000 w. *Col Guard*—Jan. 20, 1899. No. 25620 A.

Mining Law.

The Statute of Limitations, with Regard to Mining Trespass. Cites cases illustrating English law on this subject. 1200 w. *Col Guard*—Jan. 27, 1899. No. 25800 A.

Philippines.

Prospective Mines in the Philippines. Extracts from the United States Mint Report for 1898. 2700 w. *Min Rept*—Jan. 26, 1899. No. 25654.

Pumping.

Kley Pumping Engine at the Franz Shaft at Idria. (Die Kleysche Wasserhaltungs-Dampfmaschinenanlage am Franzschachte in Idria.) Karl Habermann. A description and analysis of the operation of this compound beam pumping engine, together with data and results of tests. Serial. Part I. 3000 w. 2 plates. *Oesterr Zeitschr f Berg-u Hüttenwesen*—Jan. 21, 1899. No. 26083 B.

Kley Steam Pump at the Franz Shaft (Idria). Karl Habermann. *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrated description. 1000 w. *Col Guard*—Jan. 27, 1899. Serial. 1st part. No. 25802 A.

Modern Underground Mine-Pumping Machinery. (Neuere Unterirdische Wasserhaltungsmaschinen für Bergwerke.) B. Gerdau. A very fully illustrated account of some recent mine

pumps, driven by steam, hydraulic pressure, and electricity, and placed in the mine, instead of at the surface. 2 articles. 1 plate. 7000 w. *Zeitschr d Ver Deutscher Ing*—Jan. 14, 21, 1899. No. 26060 each D.

Safety Catch.

The Oberegger Safety Catch for Mine Cages. Translated from *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrates and describes the catch and its operation. 800 w. *Ir & Coal Trds Rev*—Jan. 27, 1899. No. 25809 A.

Shafts.

New Arrangements for Closing Mine Shafts. From communication to *Glückauf* of Essen-an-der-Ruhr, Westphalia. Illustrates and describes several automatic devices, which satisfy the conditions required. 2500 w. *Col Guard*—Jan. 20, 1899. No. 25621 A.

Shaft Sinking.

Sinking Deep Shafts with the Aid of Congelation. M. Saclier. From a communication to the Societe de l'Industrie Minerale. On the precautions necessary, especially in sinking to great depths. 1300 w. *Col Guard*—Feb. 3, 1899. No. 25912 A.

The Deepening of No. II. Shaft at the Victor Mine at Rauxel. (Das Abteufen des Schachtes II. der Zeche Victor bei Rauxel.) An account of a difficult piece of shaft sinking through sand and watery strata; the Kind-Chaudron method being employed, with a closed tubular section through the quicksand. The total depth is about 800 feet. 4000 w. 2 plates. *Glückauf*—Jan. 14, 1899. No. 26084 B.

Surface Water.

Surface Water and Underground Workings. M. Leon Michel. From a paper published in the Bulletin de la Societe de l'Industrie Minerale. The injury to underground workings from surface water, and the mine owner's means of securing protection, from a French point of view. 2200 w. *Col Guard*—Jan. 20, 1899. No. 25624 A.

MISCELLANY.

Aluminum.

Aluminum as a Reducing Agent and Accumulator of Heat. (Ueber das Aluminum als Reduktionsmittel und Wärme-Accumulator.) Dr. H. Seidel. A discussion of the experiments of Goldschmidt concerning the production of high temperatures by the use of aluminum. 2000 w. *Zeitschr d Oesterr Ing u Arch Ver*—Jan. 13, 1899. No. 26051 B.

Some Properties of Aluminum. (Sur quelques Propriétés de l'Aluminium.) A. Ditte. A communication to the French Academy devoted espe-

cially to a study of the materials by which aluminum is attacked. 2500 w. *Comptes Rendus*—Jan. 25, 1899. No. 26012 D.

Bitumens.

The Genesis of Petroleum and Asphaltum in California. A. S. Cooper. Part first discusses the origin of hydrocarbons. 1800 w. *Min & Sci Pr*—Feb. 4, 1899. Serial. 1st part. No. 25868.

Diamonds.

The South African Diamond District. Prepared by the Philadelphia Commercial Museum from South African correspondence. Where the diamonds occur and a description of the machinery and methods used in mining them. 2000 w. *Mines & Min*—Feb., 1899. No. 25741 C.

Glass.

New Uses of Glass. An account of glass used as a material for paving; also for the construction of houses. 900 w. *U. S. Cons Repts*, No. 354—Feb. 18, 1899. No. 25953 D.

Natural Gas.

Fluctuations in the Composition of Natural Gas; and a Method for the Determination of Nitrogen in Gas Mixtures. Francis C. Phillips. Describes experiments made in studying the causes of fluctuation in the heating power. 4500 w. *Pro of Eng's Club of W Penna*—Dec., 1898. No. 25860 D.

Platinum.

Platinum. David T. Day. From the U. S. Geological Survey. Information concerning the production, localities of occurrence, and refining establishments. 2200 w. *Min & Sci Pr*—Jan. 28, 1899. No. 25712.

Platinum in Yukon. Clipping from a local paper giving a report of a recent discovery, which may prove of great value. 1000 w. *U. S. Cons Repts*, No. 344—Feb. 7, 1899. No. 25769 D.

Separators.

See Electrical Engineering, Power Applications.

Statistics.

Statistics of the Mineral Industry of France and Algeria in 1897. (Statistique de l'Industrie Minérale en France et en Algerie pour l'annee 1897.) A general review from the official reports, including also brief statistics of the generation and use of steam. 2500 w. *Le Génie Civil*—Feb. 4, 1899. No. 26009 D.

Talc.

Fibrous Talc in St. Lawrence County, New York. J. Nelson Nevius. Illustrates and describes the deposits as far as explored, and the manner of mining and working. 3000 w. *Eng & Min Jour*—Feb. 25, 1899. No. 26192.

MUNICIPAL ENGINEERING

GAS SUPPLY.

Acetylene.

Acetylene Gas. Vivian B. Lewes. Reviews the history of its discovery, its properties, methods of production, etc. 5400 w. *Ill. Car & Build*—Feb. 10, 1899. No. 25981 A.

Risks in the Use of Calcium Carbide and Acetylene. E. V. French. Report prepared for the Boston Manufacturers' Mutual Fire Insurance Co. 1000 w. *Eng News*—Feb. 23, 1899. No. 26147.

The Explosibility of Acetylene at Low Temperatures. (Sur l'Explosibilité de l'Acétylène aux Basses Températures.) G. Claude. A note showing great solubility of acetylene in acetone when a low temperature is maintained, and also the freedom from explosion under such conditions. 600 w. *Comptes Rendus*—Jan. 30, 1899. No. 26013 D.

The Hygienic Aspect of Acetylene. Translated and condensed from a paper read before the

Academy of Medicine, Paris. Some points concerning its excellence as an illuminant, the circumstances under which it is explosible, etc. 900 w. *Plumb & Dec*—Feb. 1, 1899. No. 26105 A.

Edinburgh.

New Gas-Works for Edinburgh. Extracts from the report of W. R. Herring, which gives an outline of the opinions of deputations sent to the English and Continental towns to collect information to guide in the laying out of the large gas-works to be built on the banks of the Forth at Granton. Plan. 6400 w. *Gas Wld*—Jan. 21, 1899. No. 25648 A.

Gas Piping.

Gas Piping in Buildings. John Lyman Faxon. Abstract of an article contributed to the *Boston Transcript*. The dangers of gas fixtures and methods of avoiding them. 1800 w. *Eng Rec*—Feb. 18, 1899. No. 26122.

Gas Works.

Gas Works at Edinburgh. A summary of Mr. Herring's report, as published in the Scotsman, Edinburgh, Jan. 16, 1899. 1500 w. U. S. Cons Repts, No. 356—Feb. 21, 1899. No. 26113 D.

Meter.

A Field for the Automatic Gas Meter. Edward A. Harman. A discussion of the automatic meter as a factor in extending the use of gas for lighting and cooking; and showing the simplification in accounting effected by its use. 1200 w. Engineering Magazine—March 1899. No. 26097 B.

Photometry.

Photometry in Germany. Digest of the instructions issued by the committee of the German Assn. of Gas and Water Eng's. for testing the illuminating power of gas. 3400 w. Jour Gas Lgt—Jan. 24, 1899. No. 25719 A.

Regulations.

Revised Gas Fitting Regulations of Boston. A copy of the regulations adopted, with a series of illustrations showing how to do work properly. 1100 w. Met Work—Feb. 25, 1899. No. 26169.

Rosin Gas.

A Southern Rosin Gas Plant. F. H. Shelton. Notes of a plant which supplies light to the Western Home of the Insane, at Staunton, Va. 1100 w. Am Gas Lgt Jour—Feb. 6, 1899. No. 25789.

Sulphate of Ammonia.

The Market for Sulphate of Ammonia Last Year. Extracts from the Annual Review, issued by Messrs. Bradley and Hirsch, of Liverpool. 3300 w. Jour Gas Lgt—Jan. 24, 1899. No. 25721 A.

Under Water.

A Gas Works Under Water. An account of the catastrophe at Littlehampton, Eng., which left the inhabitants seven days without a supply of gas. 2300 w. Jour Gas Lgt—Jan. 24, 1899. No. 25720 A.

SEWERAGE.**Sewage.**

Precipitation and Filtration of Sewage. G. C. Mason. Brief account of the sewerage system at the Southern Indiana Hospital for Insane, Evansville, Ind. 900 w. Dom Engng—Feb., 1899. No. 26164 C.

Sewage, Its Purification and Disposal. Four papers bearing on this subject, by H. Kenwood and W. Butler, S. Rideal, W. D. Scott-Moncrieff, and W. E. Adeney, with discussion. 22300 w. Jour of San Inst—Jan., 1899. No. 25783 F.

Sewage Disposal.

Sewage Disposal at Woonsocket, R. I. Illustrated description of the covered settling basins and filtration system recently built. 1500 w. Eng Rec—Feb. 18, 1899. No. 26114.

Sewage Disposal for Country Houses. Explaining how their work of purification may be carried on by means of artificial filtration and land-irrigation. 1800 w. San Rec—Feb. 10, 1899. No. 26100 A.

Sewage Disposal in Connection with Tidal Waters. H. Bertram Nichols. Particulars relating to what has been done in some of the principal English seaside towns, the methods of treatment adopted, and the points of discharge. Discussion. 5000 w. Jour of San Inst—Jan., 1899. No. 25778 F.

The Necessity of Effective Means of Sewage Disposal. Elmer L. Andrews. Considers nature's manner of disposal of wastes, the danger of allowing water to become polluted by sewage, and the means of solving the problem. 2000 w. Munic Engng—Feb., 1899. No. 25679 C.

The Report of the Connecticut Sewage Disposal Commission. Abstract of a valuable report on the disposal of sewage under conditions existing in the State named. 2300 w. Eng News—Feb. 16, 1899. No. 25971.

Sewage Purification.

Experiments with Stale and Partially Septic Sewage on the Brockton Filter Beds. Outlines the difficulties met with in disposing of sludge, and describes experiments made at Brockton, Mass. Editorial comment. 3300 w. Eng News—Feb. 2, 1899. No. 25704.

The Champaign Septic Tank. Describes the construction of two tanks at Champaign, Ill., and gives a statement of their working. 1000 w. Eng Rec—Feb. 11, 1899. No. 25845.

The Purification of Sewage by Bacteria. Arthur J. Martin. Address delivered to the Belfast Natural Hist. & Phil. Soc. Part first is largely introductory, showing the nature and properties of sewage. Ill. 2000 w. San Rec—Feb. 10, 1899. Serial. 1st part. No. 26101 A.

Sewage Sludges.

Sewage Sludges. Reviews the work of Dr. W. E. Adeney in demonstrating that sludge can be prevented from having offensive "after-putrefaction." 2000 w. Eng Rec—Feb. 4, 1899. No. 25750.

STREETS AND PAVEMENTS.**Asphalt.**

Recent Municipal Work in Washington. Describes mainly the asphalt-paving work. 2200 w. Eng Rec—Feb. 11, 1899. No. 25849.

Asphalt Mixing.

Petroleum Residuum as a Flux for Asphalt. Describes experiments made in Washington to determine whether petroleum residuum was a good softener for asphalt. 3000 w. Eng Rec—Feb. 18, 1899. No. 26117.

Brick.

Brick Pavements and Paving Brick. A. D. Thompson. On the merits of brick as a paving material, the methods of construction, the testing of paving brick and the price. 2300 w. Brick—Feb., 1899. No. 25709.

How to Make Further Improvement in the Manufacture of Paving Brick. F. Plumb. A discussion suggesting the field for experiment. 800 w. Brick—Feb., 1899. No. 25710.

The Future of Brick Pavements in Chicago. Frank W. Moulton. Reports the condition of the wood pavement, the menace to health, the advantages of good paving, etc., and urges the claims of brick as the best material to use. 3300 w. Brick—Feb., 1899. No. 25711.

London Streets.

London Street Improvements. G. Shaw Levefe. Describes what has been done of late years and what it is possible to do in the future, with a criticism of the views of J. Wolfe Barry. 7000 w. Contemporary Rev—Feb., 1899. No. 26198 D.

Pavement.

The Pavement of the Cathedral of Siena. Illustrated description and historical account of this unique pavement. 900 w. Sci Am—Feb. 11, 1899. No. 25862.

Street Grades.

Street Grades and Cross-Sections in Asphalt and Cement. Robert P. Woods. Illustrates and describes the method adopted by the writer in arranging the grades and cross-sections in a part of the business district of Wabash, Ind. 1800 w. Pro of Am Soc of Civ Engs—Feb., 1899. No. 26191 F.

Street Sweepings.

Value of Street Sweepings. Edward A. Oldham. Reports results of investigations made to determine the fertilizing value of street sweepings. 1400 w. Munic Engng—Feb., 1899. No. 25680 C.

Vancouver, B. C.

Pavements in Vancouver, B. C. A. K. Stuart. Read before the Canadian Soc. of Civ. Engs., Feb. 2, 1899. A comparison of the two kinds of pavement used, bituminous rock and wood blocks, discussing their relative merits and adaptability to this humid climate. 3800 w. Adv. Proof. No. 25926 D.

WATER SUPPLY.

Catchment Area.

The Purchase of the Catchment Area as a Means of Protecting the Sources of a Public Water Supply. J. Spotteswoode Cameron. Cites examples of unintentional fouling of water not easily controlled, unless the city has the absolute ownership of the basin. Discussion. 4500 w. Jour of San Inst—Jan., 1899. No. 25780 F.

Chattanooga.

The Water-Works Question in Chattanooga. Reviews the expediency of building public works when a private company having a good plant offers to sell its works, or to allow a board of arbitrators to establish a schedule of charges. 600 w. Eng Rec—Feb. 4, 1899. No. 25742.

Denver, Colo.

Denver and Its Water System. Brief account of the water supply of this city. 1200 w. Fire & Water—Feb. 4, 1899. No. 25785.

Electrolysis.

A Test for Electrolysis of the Jersey City Water Conduits. Gives extracts from report of A. A. Knudson, describing the method of making the test, and giving a sketch showing the course which the current took to return to the power-house. 1200 w. Eng News—Feb. 2, 1899. No. 25707.

Electrolysis in Jersey City. Illustrated report of an unusual instance of injuring the pipes by current from electric railways. 2000 w. Eng Rec—Feb. 11, 1899. No. 25847.

Filtration.

A Discussion on Filtration. Report of discussions by George W. Fuller and Allen Hazen on sand and mechanical filtration, and the turbidity of streams. 900 w. Eng Rec—Feb. 11, 1899. No. 25852.

The Report of the Pittsburg Water Filtration Commission. An abstract of a report as yet unpublished, favoring a combined system of sedimentation and slow sand filtration, and of a thorough meter system to lessen the waste. 5500 w. Eng News—Feb. 23, 1899. No. 26152.

Water Filtration Experiments, Pittsburg, Pa. A review of the experiments begun in June, 1897, to determine the best method of supplying pure water to Pittsburg. Gives results of experiments with sand and mechanical filters and sedimentation basins and similar data. 5600 w. Eng Rec—Feb. 11, 1899. No. 25846.

Fire Protection.

Fire Protection for High Buildings. Abstract of the opinions of engineers and other experts on the general need of fire protection, as given at the hearing before the Aldermen's committee and the building department of New York. 1200 w. Fire & Water—Feb. 4, 1899. No. 25784.

Fire Streams.

A Photographic Study of Fire Streams. A Marston. Abstract of paper presented at the recent meeting of the Iowa Engng. Soc. Illustrated description of the results of an investigation of fire streams, conducted with a number of ring and smooth nozzles, in which the streams were photographed, as well as measured in the usual manner. 2000 w. Eng Rec—Feb. 18, 1899. No. 26115.

London.

London Water Supply. Editorial on the report just issued by the Royal Commission on Water Supply. 3500 w. Engng—Jan. 27, 1899. No. 25794 A.

London's Underground Source of Water Supply. Reports the probability of a natural subterranean reservoir under the city, with a capacity sufficient to supply a daily yield of 7065 million gallons. Also an account of the supply of London three hundred years ago. 1300 w. Fire & Water—Jan. 28, 1899. No. 25604.

The Intercommunication Scheme of the London Water Companies. Text of the portion of the recently issued interim report of the Royal

Commission on the Metropolitan Water Supply, which refers to the three schemes for the intercommunication of the different systems. 1000 w. Jour Gas Lgt—Feb. 7, 1899. No. 25998 A.

The London Water Supply. Arthur Shadwell. An answer to an article by Mr. Shaw Lefevre, published in the Dec. number of this Review. 6600 w. Ninteenth Cent—Feb., 1899. No. 26197 D.

Philadelphia.

Plain Talk from a Water-Works Manager. A résumé of the report of the chief of the Philadelphia water-bureau concerning the result of the failure to provide money for repairs and improvements. 3000 w. Eng Rec—Feb. 11, 1899. No. 25850.

Reservoir.

A New High-Service Reservoir, Haverhill, Mass. Illustrated description of a 9,000,000 gal. reservoir in which the bank has a peculiar concrete lining. 1300 w. Eng Rec—Feb. 25, 1899. No. 26184.

Stand-Pipe.

Standpipe with Brick Casing at Racine, Wis. Illustrated description of a brick casing built around an elevated tank to prevent freezing and injurious strains from wind. 1400 w. Eng Rec—Feb. 18, 1899. No. 26116.

Venturi Meter.

The Venturi Meter. Report of the Committee on Science and the Arts on the inventions of Clemens Herschel, Frederick N. Connet and Walter W. Jackson. This meter is designed for the measurement of the flow of liquids in pipes of large dimensions. Ill. 8400 w. Jour Fr Inst—Feb., 1899. No. 25775 D.

Water Analysis.

I. Recent Progress in the Methods of Water Analysis. Clarence A. Seyler. (Abstract). II. Interpretation of Results of Water Analysis. Sidney Barwise. The standard methods and results are discussed, and the need of more than a single chemical analysis. Discussion. 6500 w. Jour of San Inst—Jan., 1899. No. 25782 F.

Water Mains.

Carrying a 30-in. Water Main Over and Through a Masonry Arch Bridge at Hartford, Conn. E. D. Graves. Brief extract from paper read before the Conn. Soc. of Civ. Engs. & Surv., with drawings and view showing details of a novel method. 350 w. Eng News—Feb. 23, 1899. No. 26151.

Movement of Water-Mains in Connection with Pennsylvania Avenue Subway Work. Allen J. Fuller. An account of the changes made necessary by the subway and the relaying of the mains. Ill. 1300 w. Pro of Eng' Club of Phila—Jan. 1899. No. 26,126 D.

Water Softening.

Water Softening at Southampton, England. James H. Fuertes. Illustrated description of a plant which reduces the hardness of 4,000,000 gals. daily from 18 to 5 degrees. 2400 w. Eng Rec—Feb. 4, 1899. No. 25746.

Water Tower.

The New Water Tower for the Towns of Mulheim, Deutz and Kalk. (Der Neue Hochbehälter des Wasserwerkes für die Städte Mülheim a. Rh., Deutz, und Kalk.) F. Thometzek. A description of the manner in which the capacity of a water tower was increased by the erection of a second tank above the original one. Detail drawings are given. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—Jan. 28, 1899. No. 26065 D.

Water-Works.

The Gainsborough Water-Works. A brief explanation of the scheme for extending these works, and the vicissitudes through which it has passed, with an account of the recovery of a boring tool that was lost at a depth of 725 feet, on April 1, 1897. 1300 w. Jour Gas Lgt—Feb. 7, 1899. No. 25997 A.

York Supply.

The Reconstruction of the York, Pennsylvania, Water-Supply. John Birkinbine. Describes the method followed in correcting defects in a reservoir, and also the present plant. 4500 w. Pro of Eng's Club of Phila.—Jan., 1899. No. 26128 D.

MISCELLANY.**Artisans' Dwellings.**

The Erection of Artisans' Dwellings by Municipal Corporations. Describes this question in its relation to London and Glasgow, and concludes the city is not justified in erecting dwellings at a cost at which profitable results are not obtained. 2000 w. Builder—Jan. 28, 1899. No. 25824 A.

Franchises.

Franchises, Robert E. McKisson. Address at Zanesville, O., before the Ohio Municipal League. Discusses the need of correcting the abuses of franchises in American cities, favoring municipal ownership of water and lighting plants. 1600 w. Pro Age—Feb. 15, 1899. No. 25945.

Heat of Cities.

Vegetation a Remedy for the Summer Heat of Cities. Stephen Smith. A plea for the cultivation of trees, shrubs, plants, vines, and grasses in the streets of New York, for the improvement of the public health, for the comfort of summer residents, and for ornamentation. 7000 w. Ap Pop Sci M—Feb., 1899. No. 25666 D.

Municipal Co-operation.

Municipal Co-operation a Possible Substitute for Consolidation. Refers to the experience of

Boston and Newark, and their suburbs, as cases of municipal co-operation, and the advantages of consolidation, as represented by Greater New York, favoring co-operation. 3000 w. Eng News—Feb. 16, 1899. No. 25970.

Municipal Enterprise.

Municipal Factories. Editorial discussion of the functions to be undertaken by public bodies, and the absurdity of modern socialistic theories. 2200 w. Engng—Feb. 10, 1899. No. 25983 A.

The Cost of Municipal Enterprise. Dixon H. Davies. An interesting consideration of this subject favorable to private companies, and presenting the disadvantages and dangers attending municipal enterprise. Also discussion. 11200 w. Jour Soc of Arts—Feb. 3, 1899. No. 25898 A.

Municipal Socialism.

Municipal Functions: A Study of the Development, Scope and Tendency of Municipal Socialism. Milo Roy Maltbie. A study of what the municipality does; discussing the historic development; the scope of present municipal activities, and the future outlook. 60000 w. Munic Af—Dec., 1898. No. 25877 E.

Refuse Disposal.

Refuse Disposal at Barren Island, New York. Reviews the report of Dr. E. L. Martin, J. B. Taylor and John Bogart on the nature and offensiveness of the plants where the garbage and dead animals of New York are converted into fertilizers and soap grease. 2000 w. Eng Rec—Feb. 4, 1899. No. 25749.

The Utilization of City Refuse in Boston, Mass. Illustrated description of a plant for sorting the combustible refuse of the city and burning the useless portions. 1800 w. Eng Rec—Feb. 25, 1899. No. 26186.

RAILWAY AFFAIRS**CONDUCTING TRANSPORTATION.****Accident.**

The Accident on the London and Northwestern Railway at Penmaenmawr. Brief illustrated description. 300 w. Engng—Jan. 20, 1899. No. 25613 A.

Train Accidents in the United States in December. Detailed list, with classified summary and additional information. 4400 w. R R Gaz—Feb. 3, 1899. No. 25732.

Employees.

The Discipline and Education of Railway Employees. George R. Brown. Concerning the success of the Brown System of Discipline, which has been adopted by fifty-three American railways. 2200 w. Am Eng & R R Jour—Feb., 1899. No. 25649 C.

Fast Mail.

A New Fast Mail Train Across the United States. An account of the first run of the train which has shortened the time between New York and San Francisco by twelve hours, and the proposed reduction of twenty to twenty-four hours. 1500 w. Engr, Lond—Feb. 10, 1899. No. 25979 A.

Fast Trains.

London to Brighton in an Hour. Charles Rous-Marten. An account of the running of a Pullman car express from Victoria Station to Brighton, with description of the train, service, etc. 1600 w. Engr, Lond—Jan. 27, 1899. No. 25810 A.

FINANCIAL.**Central Pacific.**

The Central Pacific Settlement and Readjustment. On the plan for the readjustment of the corporation's finances as agreed upon. 900 w. Bradstreet's—Feb. 25, 1899. No. 26194.

Earnings.

Gross Railway Earnings Still Growing. Gains shown in earnings over the same month a year ago. 1000 w. Bradstreet's—Feb. 11, 1899. No. 25873.

Net Railroad Earnings in 1898. Discusses some of the causes that have affected the earnings of railroads of the United States in recent years, giving tabulated statement of gross and net earnings for twelve months ending in Dec. 1000 w. Bradstreet's—Feb. 18, 1899. No. 25955.

MOTIVE POWER AND EQUIPMENT.**Auxiliary Railways.**

Light Railways in France. Illustrations and information of the subsidiary system affiliated to that of the Western Railway of France. Also describes the type of locomotives used. 1000 w. Engng—Jan. 20, 1899. No. 25611 A.

Cars.

80,000 Lbs. Capacity Cars for the Cleveland, Cincinnati, Chicago and St. Louis. Brief illustrated description. 400 w. R R Gaz—Feb. 17, 1899. No. 25946.

Coal Consumption.

Comparative Coal Consumption of Simple and Compound Locomotives. Observations and records taken on the La Crosse Division of the Chicago, Milwaukee & St. Paul R. R. 400 w. R R Gaz—Feb. 10, 1899. No. 25875.

Disinfection.

The Thorough Disinfection of Railway Cattle Cars. (Die Wirksame Desinfection der beim Thiertransporte Verwendeten Eisenbahnwagen. Adolf Freund. A description of the methods adopted in various parts of Germany for the prevention of the spread of contagious diseases in the railway transport of cattle. Two articles. 10,000 w. Zeitschr d Oesterr Ing u Arch Ver—Jan. 13, 20, 1899. No. 26052 each B.

Electric Locomotives.

The Electric Locomotive of the Paris-Lyons-Mediterranean Company. (Locomotive Electrique de la Cie P.-L.-M.) A very complete account of the high-speed express locomotive of the P. L. M. Railway in France. Speeds of 60 miles per hour, with a train of 100 tons, were attained; storage batteries of the Fulmen type being employed. 4500 w. *Energie Electrique*—Jan. 1, 1899. No. 26035 D.

The Electrical Locomotive of the Paris, Lyons & Mediterranean Railroad. Illustrates and describes the locomotive, giving the results obtained on the main line between Paris and Melun. 2000 w. *Elec Wld*—Feb. 4, 1899. No. 25688.

The Storage Battery Locomotive of the P. L. M. Railway, France. From *La Nature*. Illustrated description. 700 w. *Elec Eng*, N. Y.—Feb. 23, 1899. No. 26167.

Freight Cars.

Building 15 Freight-Cars per Day—Chicago, Milwaukee and St. Paul Railway. Describes the plan by which this creditable performance is carried on. The record was not broken from the middle of Jan., 1898, to the 6th of June. Ill. 2000 w. *Eng & R R Jour*—Feb., 1899. No. 25650 C.

Head-Light.

Electric Arc Lamp for Locomotive Head-Light. (Elektrische Bogenlichtstirnlampe für den Fahrdienst auf Eisenbahnen.) Max Schiemann. A description of the Wagenhals lamp and an account of its performance, with data as to cost of maintenance. 2500 w. *Elektrotech Zeitschr*—Jan. 19, 1899. No. 26069 B.

Locomotive Boilers.

The Loss of Heat from Locomotive Boilers. An account of the most elaborate series of tests ever undertaken to measure the loss of heat under the conditions of service. Also editorial. Abstract of report of tests given at meeting of Western Ry. Club, by Robert Quayle. 5400 w. *Eng News*—Feb. 23, 1899. No. 26149.

Locomotives.

Consolidation Locomotive, L. I. R. R. Half-tone view and side, rear and sectional elevations of locomotives constructed for the Long Island Railroad, with dimensions. 500 w. *Ry & Engng Rev*—Feb. 11, 1899. No. 25892.

Consolidation Locomotives for the Oregon Railroad & Navigation Co. Illustrated description giving dimensions. 600 w. *R R Gaz*—Feb. 3, 1899. No. 25731.

Diagrams of Runs by French Engines. Representing in graphic form the performances of two different classes of French engines described in the articles by Charles Rous-Marten. 200 w. *Engr*, Lond—Jan. 20, 1899. No. 25631 A.

Eight-Wheel Passenger Locomotive, F. C. & P. R. R. Illustrated description, with dimensions. 500 w. *Ry & Engng Rev*—Feb. 18, 1899. No. 26132.

Express Passenger Locomotive for the Belgian State Railways. Illustrated detailed description, with dimensions. Two-page plate. 1000 w. *Engng*—Feb. 3, 1899. No. 25908 A.

Grates, Ash Pans and Dampers for Anthracite and Bituminous Coal Locomotives. Illustrates and explains the practice of the Pennsylvania Railroad. 900 w. *Am Eng & R R Jour*—Feb., 1899. No. 25651 C.

New Compound Locomotives for the Austrian State Railways. (Les Nouvelles Locomotives Compound de la Compagnie des Chemins-de-Fer de l'Etat Autrichien.) With illustrations and specifications of the various types of engines, all of the two-cylinder compound design. 1200 w. *Le Génie Civil*—Feb. 4, 1899. No. 26008 D.

Specifications of a Four-Wheel Coupled Passenger Engine—Great Northern Railway, Ireland. A copy of the specification in full, with working drawing. 4200 w. *Engr*, Lond—Jan. 20, 1899. No. 25634 A.

The Evolution of the Locomotive Engine. William P. Marshall. Extracts from a recent paper before the Institution of Civil Engineers, relating to important changes in the details of

English locomotives. 1800 w. *R R Gaz*—Feb. 24, 1899. No. 26175.

Rating.

Tonnage Rating for Locomotives. Reports the tests made on the Peoria & Eastern Div. of the C., C. & St. L. Ry., to determine the maximum number of tons that could be hauled in each direction up all the ruling grades. 1500 w. *R R Gaz*—Feb. 17, 1899. No. 25949.

Resistance.

A New General Formula for Train Resistance. Gives a general formula which the editor says appears to be applicable to passenger trains of all weights, running at all speeds. Worked out by John Lundie as a result of a long series of tests of trains in actual service. 1700 w. *St Ry Jour*—Feb., 1899. No. 25726 D.

A New Train Resistance Formula. Editorial criticism of the Lundie formula given in the *Street Railway Journal* for February. 2400 w. *R R Gaz*—Feb. 17, 1899. No. 25951.

Train Resistance. Editorial discussion of formula of John Lundie, given in the *Street Railway Journal*. 800 w. *Engng*—Feb. 10, 1899. No. 25984 A.

Rolling Stock.

Modern Rolling Stock. Abstract of paper presented by W. McIntosh at the Dec. meeting of the Northwest Ry. Club. Asserts that a track and road-bed that will carry locomotives of 100 tons and cars of 50 tons capacity will soon be necessary. 1200 w. *R R Gaz*—Feb. 17, 1899. No. 25950.

The Shortage of Rolling Stock. From the *London Railway Times*. A statement of conditions in Great Britain, especially in reference to coal transportation, and the difficulty in solving the problem. 1400 w. *Col Guard*—Feb. 3, 1899. No. 25916 A.

Springs.

Underhung Driving Spring Rigging. L. R. Pomeroy. Calls attention to the difficulties that may arise in the changed conditions and their remedy. Ill. 700 w. *Am Eng & R R Jour*—Feb., 1899. No. 25652 C.

NEW PROJECTS.

Great Central Ry.

The Great Central Railway. A description of this important addition to the English railway system, with map indicating route. 4800 w. *Engng*—Feb. 10, 1899. Serial. 1st part. No. 25982 A.

The Great Central Railway from Annesley to Nottingham. An illustrated account of the construction and route, and the buildings, etc. 3300 w. *Engr*, Lond—Feb. 3, 1899. No. 25918 A.

Improvements.

South Eastern Railway Improvements. On changes being made in the widenings, stations, etc., of this English railway. 1500 w. *Engr*, Lond—Feb. 10, 1899. No. 25975 A.

Japan.

The Railways of Hokkaido, Japan. S. Tanabe. Brief account of the extent, population, etc., of the island, with a short physical description of the new lines constructed and surveyed. Ill. 800 w. *Eng News*—Feb. 23, 1899. No. 26148.

Little Railways.

Little Railways for South African Colonies. Editorial discussion of the conditions prevailing in these colonies, and the advisability of constructing a 2-ft. gauge line. Considers the views of C. Bodtker, given in a recent pamphlet. 2000 w. *Engng*—Jan. 20, 1899. No. 25615 A.

Philippines.

Railroading in the Philippines. A description of the single railroad line in these islands, the equipment, and the country through which it passes. 1800 w. *Sci Am*—Feb. 25, 1899. No. 26155.

Siberia.

Notes from the Statistics of the Siberian Railway. (Einige Mittheilungen aus den Statistischen Veröffentlichungen der Sibirischen Eisenbahn.) An abstract of the reports upon the cost of the Trans-Siberian railway from 1893 to 1897, giving data as to progress and cost of the work. 1800 w. *Glaser's Annalen*—Feb. 1, 1899. No. 26046 D.

The Railways of Siberia and Eastern China. (Les Chemins de Fer de Sibirie et de l'Est de la Chine.) R. de Batz. An excellent account of the present condition of the work on the Trans-Siberian Railway and its connection with the Eastern Railway of China, with map and numerous views of stations. 3000 w. *Le Génie Civil*—Jan. 21, 1899. No. 26001 D.

The Trans-Siberian Railway. Its immediate prospects. Extracts from an essay by M. Belinski, in the *Russki Vestnik* are given, and comments. 800 w. *Engr, Lond*—Jan. 20, 1899. No. 25629 A.

The Trans-Siberian Railway and the Coal Resources of Siberia. Considers this new line and its economic results, and the various coal fields that it will open. Map and Ill. 4000 w. *Ir & Coal Trds Rev*—Jan. 27, 1899. No. 25808 A.

Single Rail.

The Proposed Lightning Express Railway Between Liverpool and Manchester. Proposing to construct and work a railway on this system which will enable passengers to travel between Liverpool and Manchester in eighteen minutes. 1200 w. *Transport*—Jan. 20, 1899. No. 25639 A.

PERMANENT WAY AND FIXTURES.**India.**

Railway Location and Surveys in Rajputana, India. C. H. Croudace. A beautifully illustrated paper upon the work on the location of the Delhi-Karachi direct line through the sand-ridge district in Northern India. 4000 w. *Engineering Magazine*—March, 1899. No. 26092 B.

Oneonta Shops.

Delaware & Hudson Shops at Oneonta. Illustrates and describes the appliances used in these shops, giving also a brief description of the buildings. 2500 w. *R R Gaz*—Feb. 3, 1899. No. 25733.

Roadmasters.

Civil Engineers for Maintenance of Way. Jerry Sullivan. The writer does not consider that the education as a civil engineer equips a man for the position of roadmaster. The duties he may be called upon to perform are stated, and the training needed. 2700 w. *Ry & Engng Rev*—Jan. 28, 1899. No. 25605.

Signals.

Inspection of and Repairs to Automatic Block Signals. W. A. D. Short. Read before the Ry. Signaling Club of Phila. Discusses the distribution of labor, and what should be required of inspectors, the methods, etc. 1200 w. *R R Gaz*—Feb. 24, 1899. No. 26174.

Railway Signaling. Charles Hansel. Considers the most approved methods of guarding

against collisions, signaling on single track, protection of grade crossings and junctions, etc., with discussion. Ill. 15000 w. *N Y R R Club*—Jan. 19, 1899. No. 25931.

The Distant Signal. E. D. Wileman. Abstract of a paper presented at the Philadelphia meeting of the Railway Signaling Club. Outlines a satisfactory installation at a very difficult location, and discusses various types of distant signal. 2200 w. *Eng News*—Feb. 23, 1899. No. 26150.

Station.

New Passenger Station at Quincy, Ill.; C., B. & Q. R. R. Plan and elevation are given, with description. 500 w. *Eng News*—Feb. 16, 1899. No. 25969.

Subway.

Pennsylvania Avenue Subway and Tunnel. George S. Webster. A description of the work of abolishing seventeen grade-crossings of the Phila. & Reading Ry., on the line of Pennsylvania Ave., in the city of Philadelphia. Ill. 4800 w. *Pro of Engs' Club of Phila.*—Jan., 1899. No. 26125 D.

The Passy Subway. (Le Souterrain de Passy.) A. da Cunha. With illustrations of the progress of the work, and a map showing the line, as well as the covered and uncovered parts of the subway now under construction in Paris. 2500 w. *La Nature*—Jan. 28, 1899. No. 26028 B.

Track.

Broad Flanges vs. Tie Plates. Editorial discussion of an article by C. P. Sandberg, indexed from *London Engineering*, on the advantage of using heavier rails for railways laid with flange rails. 1800 w. *R R Gaz*—Feb. 10, 1899. No. 25876.

Track Elevation.

Track Elevation in Chicago. Four illustrated papers of track elevation and depression in Chicago, with discussion. The papers are by W. H. Coverdale, H. W. Parkhurst, G. W. Vaughn, and Marvin H. Dey. 14000 w. *Jour W Soc of Engs*—Dec., 1898. No. 25674 D.

Zurich.

The New Railway Station at Zurich. (La Nouvelle Gare de Zurich.) MM. Berquet & Margot. A general description of this new terminal, providing accommodations for eight railways. 2000 w. 1 plate. *Rev Gen des Chem de Fer*—Jan., 1899. No. 26029 F.

TRAFFIC.**Cheap Rates.**

Passenger Classification. William G. Raymond. A comparison of statistics, as furnished by the Interstate Commerce Commission, as an argument for reducing rates. 2000 w. *R R Gaz*—Feb. 10, 1899. No. 25874.

German Railways.

A Review of the Work of the Union of German Railway Administrations. Alex Bewley. An account of the remarkable work accomplished by this association. 3500 w. *Ind Engng*—Jan. 21, 1899. No. 26111 D.

STREET AND ELECTRIC TRAMWAYS

Accumulators.

Storage Batteries and Railway Power Stations. Robert McA. Lloyd. Abstract of a paper read before the Am. Inst. of Elec. Eng. The application of the storage battery to electric railway operation is discussed, and the advantages shown. 3500 w. *Eng News*—Feb. 23, 1899. No. 26153.

The Use of Accumulators in Tramway Driving. (Bahn-Betrieb mit Accumulatoren.) A paper before the German Railway Society, discussing the advantages of storage batteries for equalizing the

load upon the power plant. 5000 w. *Glaser's Annalen*—Feb. 1, 1899. No. 26045 D.

American Tramways.

Street Railway Mileage, Cars and Capitalization in America. Tabulated statement, giving a compilation of the electric, cable and horse railways of the United States and Canada. *St Ry Jour*—Feb., 1899. No. 25728 D.

Argentine Republic.

Electric Railroading in the Argentine. Illustrated description of the electric lines of Buenos

Aires. 1800 w. St Ry Jour—Feb., 1899. No. 25723 D.

Ball Bearings.

The Application of Ball Bearings to Tramways. (Anwendung von Kugellagern bei Strassenbahnen.) R. v. Podoski. With illustrations of the bearings used on various Swiss tramways, and very full data of traction tests, with numerous diagrams. Two articles. 6000 w. Elektrotech Zeitschr—Jan. 26, Feb. 4, 1899. No. 26072 each B.

Boston Subway.

The Boston Subway. An interesting illustrated description of this great engineering work, and the advantage it has already proved to the much congested traffic. 5500 w. Elec Wld—Feb. 11, 1899. No. 25890.

Electric Locomotive.

See Railway Affairs, Motive Power.

Electric Railroads.

Electric Street Railroads in England. Outlines the evidences of a great awakening in England in the use of electricity, and the chances for American manufacturers and contractors in connection with the work. 2800 w. U. S. Cons Repts, Vol. LIX., Feb., 1899. No. 25664 D.

Electrical Traction.

Power Distribution for Electrical Traction. Ernest Wilson. Remarks on power distribution in general, with an examination of present practice of delivering the energy to the cars. 4000 w. Engr, Lond—Jan. 20, 1899. No. 25627 A.

Some General Observations on Electric Traction. Horace F. Parshall. Read before the Northern Soc. of Elec. Engrs. Discusses the steam generating plant, speed of engines, system of transmitting, and various matters relating to the designing and working. Brief report of discussion. 4000 w. Ind & Ir—Jan. 27, 1899. No. 25814 A.

Electrolysis.

See Municipal Engineering, Water Supply.

Fares.

Methods for Collecting and Registering Fares on Interurban Lines. F. H. Fitch. The problem of collection and registration of fares is discussed, with description of form designed by the writer. 1800 w. St Ry Rev—Feb. 15, 1899. No. 25959 C.

Glasgow.

The Glasgow Corporation Electric Tramways. Part first explains why electric traction was adopted, and describes the construction of the line. Ill. 3800 w. Engr, Lond—Feb. 10, 1899. Serial. 1st part. No. 25978 A.

Higher Voltage.

Notes on Higher Voltage Trolley Wires. Ernest Kilburn Scott. Notes on raising the voltage of trolley lines as an expedient when tram lines extend great distances from the power station. 1500 w. Elec Rev, Lond—Feb. 10, 1899. No. 25991 A.

Interurban.

The Detroit, Ypsilanti, and Ann Arbor Interurban Electric Railway. Illustrates and describes the road and its equipment. 1000 w. Elec Eng, N. Y.—Dec. 22, 1898. No. 24670.

The Interurban Electric Railways Around Detroit. An illustrated detailed description of an extended system of these railways. Also editorial. 5000 w. St Ry Jour—Jan., 1899. No. 25031 D.

The Wilkes-Barre Interurban Railway. Illustrates and describes an interesting line, extending from Luzerne, Pa., to Harvey's Lake, which has proved successful where a steam line failed. 1300 w. St Ry Rev—Feb. 15, 1899. No. 25964 C.

Joint.

The Falk Joint. (Joints Falk.) An account of the Falk cast rail joint for electric tramways, as applied in France, with illustrations from photo-

graphs of the pouring of the metal. 3000 w. plate. La Revue Technique—Jan. 10, 1899. No. 26015 D.

Jungfrau.

The Jungfrau Railway. (Le Chemin de Fer de la Jungfrau.) R. Godfernaux. A general description of the three-phase electric rack railway now under construction to the summit of the Jungfrau, in Switzerland, with topographical map. 4000 w. Rev Gen des Chem de Fer—Jan., 1899. No. 26030 F.

The Jungfrau Railway. Views of the section just opened, with reports, by various authorities, upon the project. 2800 w. Engr, Lond—Feb. 10, 1899. Serial. First part. No. 25974 A.

Madrid.

Madrid Electric Tramways. An illustrated detailed account of these tramways, with a brief sketch of the city. 3000 w. Ry Wld—Feb. 9, 1899. No. 25996 A.

Materials.

Purchase, Inspection and Distribution of Street Railway Material and Supplies. H. W. Brooks. Review of a paper and discussion presented at the meeting of the New York Railroad Club, Oct. 20, 1898, with application to street railway practice. 3700 w. St Ry Rev—Feb. 15, 1899. No. 25961 C.

Paris.

The Metropolitan Railway of Paris. (Le Métropolitain de Paris.) G. Leugny. An account of the present state of the work, with plans showing the arrangement of the tunnels at important intersections and terminals. 3000 w. La Revue Technique—Jan. 10, 1899. No. 26016 D.

Pittsburg.

New Power Station, Shops and Pleasure Resort of the Consolidated Traction Company, Pittsburg. Description and illustrations. 4500 w. St Ry Rev—Feb. 15, 1899. No. 25965 C.

Power.

The Computation of the Power Required for Electric Street Railways. (Berechnung des Kraftbedarfes von Elektrischen Strassenbahnen.) Ludwig Schroeder. A discussion of the graphical method of plotting the varying demands for power, showing the use of accumulators for equalizing the load upon the motive power. 6000 w. Elektrotech Zeitschr—Feb. 2, 1899. No. 26078 B.

Public Relations.

The Street Railway as a Public Institution and Its Relations to the Public. H. H. Windsor. Extracts from an address before the Political Economy Club, Univ. of Chicago. 8000 w. St Ry Rev—Feb. 15, 1899. No. 25962 C.

Roadway Department.

Roadway Department of the Union Traction Company, Philadelphia. Describes the practice of this department and the appliances used. Ill. 2200 w. St Ry Jour—Feb., 1899. No. 25725 D.

Snow.

Snow-Bound Street Car Systems. William Herbert Donner. Suggestions for keeping lines open, and details concerning the management. 900 w. Am Elect'n—Feb., 1899. No. 25831.

Street Railways.

The Relation of the Street Railway to the Public. James F. Lardner. Extract from a paper read before the Contemporary Club. The extract given refers to the price of a ride, and the giving more for the money, the value of franchises, etc. 1500 w. St Ry Rev—Jan. 15, 1899. No. 25371 C.

Switzerland.

The Stausstad-Engelberg Electric Railway. Illustrated detailed description of an electric line connecting this village, Lake of Lucerne, with a favorite tourist's resort. 2200 w. Elect'n, Lond—Jan. 27, 1899. No. 25818 A.

BOOK REVIEWS

SANITARY ENGINEERING. By Wm. Paul Gerhard, C. E., Author and Publisher New York, 1898.
ELEMENTS OF SANITARY ENGINEERING By Prof. Mansfield Merriman. New York: John Wiley & Sons. London: Chapman & Hall, 1898.

It is not often that two books are offered for review at the same time, which deal with the same subject and which offer greater opportunities for comparison than do "Sanitary Engineering" and "Elements of Sanitary Engineering." They not only offer opportunities but they demand a comparison, in making which we shall follow the law, "For the last shall be first and the first shall be last."

In a foot-note, we are told by Mr. Gerhard that 101 pages of this book comprise a lecture which was delivered before the Franklin Institute, on Feb. 15, 1895, and in another foot-note that the rest of the 132 pages is reprinted from the *Sanitarian*, of June, 1895; a third foot-note tells us that the author and publisher has at least a quoting acquaintance with "Lucile" and that he (the author and publisher) agrees with one of the statements made by "Owen Meredith," which statement, however, has nothing whatever to do with sanitary engineering. This fact is entirely consistent with the rest of the book, since in it we find very little that has to do with sanitary engineering and we are forced to one of three conclusions: 1. Sanitary engineering must still have been only a name and not yet a thing, in 1895. 2. The author and publisher may not have been well acquainted with the subject. 3. The author and publisher may have a low opinion of his audience.

There is no more doubt as to the value of Prof. Merriman's work than there is concerning the futility of publishing such slipshod inanities as are contained in the book brought out by Mr. Gerhard.

Prof. Merriman begins with an interesting statement of what sanitary engineering really is, its professional limits and its cognate branches. Historical notes, the classification of diseases, statistics of mortality,

bacteriology, organic matter, filth and disease, impure air and disease, drinking water and disease, matter in natural waters, chemical analysis of water, biological analysis of water, interpretation of analysis and finally, the results of sanitary science, which completes Chapter I. and page 46.

Chapter II. deals with Water and its Purification, Chapter III. with Water Supply Systems, Chapter IV. with Sewerage Systems and Chapter V. with the Disposal of Garbage and Sewage.

Since the book is partly intended for students, a series of problems or exercises follows each chapter: from those appended to Chap. I., which in all number 25, we abstract two: "5. Give sketches showing the characteristic forms of the three classes of bacteria. What is the name of the germ that causes typhoid fever?" "10. Consult Part 1, of Experimental Investigations by the State Board of Health of Massachusetts (Boston, 1890), and give an account of the work for determining the normal chlorine in that State."

To city engineers and all those who are employed or interested in city matters, we believe that the work will be of immense value, not wholly for what it will teach them in exact knowledge, although that will be much, but because a single reading of it is enough to show the absolute necessity of technical advice in what concerns the water-supply, street-cleaning and garbage disposal of cities and even small towns. "Large oaks from little acorns grow," small towns in time become cities, and the mistakes of the youth cause the death of the man. The right time to start a system of sewage disposal is during the village state and if a small community takes its drinking water from an impure source, the error is likely to be perpetuated. Therefore, it seems that it is not so necessary to create sanitary engineers as to create a wide demand for them and it is in performing the latter function that we hope the most from this book.

NEW CATALOGUES AND TRADE PUBLICATIONS

*These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.*

Risdon Iron Works, San Francisco, Cal., U. S. A.—Handsomely illustrated catalogue of gold dredging machinery, showing numerous applications of methods of sub-aqueous mining by the use of the Risdon gold dredge. The applicability of the machine for dredging on banks, in rivers and other locations is well shown. The catalogue also contains useful information about apparatus and methods of hydraulic mining.

Merchant & Co., Philadelphia, Pa., U. S. A.—Neatly printed little pamphlet entitled "How Roofing Tin Is Made," giving descriptions of the cheap acid-flux process and the high-grade, palm-oil flux method, and showing the advantages of the latter method, used by the writers for the production of various brands of high-grade roofing plate.

Queen & Co., Philadelphia, Pa., U. S. A.—Fully illustrated pamphlets consisting of (a) a manual of engineers' and surveyors' instruments, giving very complete accounts of the high-grade transits, theodolites, levels and other instruments, with much valuable information relating to adjustments, care and use; and (b) a manual of practical draughting, forming a useful hand-book to the use of drawing instruments.

The Grant Machine Tool Works, Cleveland, Ohio, U. S. A.—Catalogue of fine machine tools, including lathes, boring machines and milling machines and accessories, also list of balls of steel and other hard metal for ball bearings.

Detroit Graphite Manufacturing Company, Detroit, Mich., U. S. A.—Handsome catalogue describing the nature and merits of the Superior Graphite Paint for the protection of metal work from corrosion. Many illustrations of buildings and other structures upon which the paint has been used are given.

Andrew J. Corcoran, Jersey City, N. J., U. S. A.—Finely illustrated catalogue of the Corcoran windmill, as adapted for pumping water, showing many installations on handsome estates in various parts of the United States. Excellent endorsements from a number of prominent users are given.

Sprague Electric Company, New York.—Architects' and engineers' bulletin, containing much useful and valuable information concerning automobiles, surface-contact electric railways, electric motors, electric heating, interior wiring and other matters of interest. The typography and illustrations are particularly worthy of commendation.

Fraser & Chalmers, Chicago, Ill., U. S. A.—Catalogue No. 34, describing and illustrating the Sederholm boiler, especially intended for high pressures and large units. Valuable tables of the properties of saturated steam, of evaporation factors, and other useful matter are given.

The C & C Electric Company, New York.—Bulletin No. 128, with illustrations and specifica-

tions of four, six and eight pole dynamos, arranged either for direct connection to engine shaft or for belt driving. Details of foundations and of parts are also given.

The Hoppes Manufacturing Company, Springfield, Ohio, U. S. A.—Catalogue of the Hoppes steam separators, oil eliminators and feed-water heaters. Various forms of separators are shown for different locations, and details of dimensions and prices of the various sizes given.

Nicholson File Company, Providence, R. I., U. S. A.—File Philosophy, containing many useful hints and instructions about the proper use of files, and forming a reprint of the most important portions of Mr. William T. Nicholson's treatise on files, now out of print.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.—Record of recent construction, No. 10, January, 1899. Contains illustrations and specifications of locomotives recently built by this firm for many parts of North and South America, and for Russia. Special attention is called to the locomotive of the Forney type for the Cauca Railway of the United States of Colombia for 4 per cent. grades and curves of 200 feet radius.

J. H. Williams & Co., Brooklyn, New York, U. S. A.—Catalogue of drop forgings of iron, steel, copper, bronze and aluminum, with illustrations and price lists of wrenches, crank handles, eye-bolts, machine parts, bicycle forgings and golf club heads.

The Hohmann & Maurer Manufacturing Company, Rochester, N. Y., U. S. A.—Pamphlet containing illustrations of various forms of thermometers for industrial uses, with comments and testimonials from users.

Buffalo Forge Company, Buffalo, N. Y., U. S. A.—Small catalogue of the Buffalo down-draft forges with down-draft exhaust hoods for removing the smoke as it is generated.

Reeves Pulley Company, Columbus, Ind., U. S. A.—Large catalogue of the Reeves variable speed countershaft, showing its adaptability to overhead countershafts for machine-tool driving, and also to the control of speed of mechanically propelled vehicles.

Fred M. Locke, Victor, N. Y., U. S. A.—Illustrated catalogue of porcelain and glass insulators for high voltage electric power transmission. Insulators for a great variety of work are shown, and a list of users on long-distance power transmission in many parts of the United States, as well as in Mexico, South America, Japan and Siam, are given.

Graham, Morton & Co., Limited.—Black Bull St., Leeds, England.—Illustrated catalogue of conveying plant and power transmission machinery; also of hydraulic pressed colliery tubs, gas and chemical plant, coal-washing machinery and structural iron work.

Marshall, Sons & Co., Limited, Gainsborough, England.—(a) Steam engine and boiler catalogue, describing and illustrating a full line of portable and stationary engines, boilers, etc., with price list. (b) Illustrated description of the firm's works.

The Brush Electrical Engineering Company, Limited, 49 Queen Victoria St., London, E. C.—Cloth bound illustrated catalogues (a) of alternators, dynamos, motors, the Universal steam engine and electrical accessories; (b) of locomotives, tram cars and goods wagons. The information given is most complete.

Rosling & Appleby, Trafalgar Works, Bradford, England.—(a) Illustrated catalogue of dynamos and motors, coal-cutting machines and alternating current motors, with prices and full information. (b) Several sheets with illustrations of recently constructed machinery.

Bryan Donkin & Co., Limited, Bermondsey, London.—Illustrated catalogues of (a) valves and other fittings for gas works; (b) "The Perret" patent furnace for burning refuse fuels; (c) exhausting plant, fans, etc.; (d) miscellaneous sheets, pricing fans, steam valves, oil and gas engines.

Joseph Baker & Sons, 58 City Road, London.—(a) Illustrated catalogue and price list of fruit cleaning and drying machinery, coffee-roasting machines, tea cutting and mixing plant. (b) Circular illustrating and pricing patent disc coffee mills.

G. Diechmann & Sohn, Berlin, Germany.—Illustrated catalogue of English and American machine tools suitable for the German market. The machines are divided up according to the names of the manufacturers.

Fraser & Chalmers, 43 Threadneedle St., London.—Pamphlet describing the "Sederholm" boiler, specially suitable for high pressures and large units. Fully illustrated.

T. Richardson & Sons, Limited, Hartlepool, England.—Illustrated pamphlet describing Morison's evaporator and feed water heater for marine boilers, also giving particulars of Geddes patent pulsator water drainers.

Merryweather & Sons, Limited, 63 Long Acre, London.—Cloth bound catalogue, entitled "Water Supply," giving a description of the engineering procedure and plant necessary for water supply and power plant for villages and country houses.

R. W. Blackwell & Co., 39 Victoria St., Westminster.—Illustrated catalogue and price list of the "Chicago" crown and plastic rail bonds, with full description of method of laying, tools required and costs.

James Clegg, 10 Milnrow Road, Rochdale, England.—Catalogue of second-hand books for the engineering profession.

H. J. H. King & Co., Nailsworth, Glos., England.—Illustrated catalogue of speed governors for turbines and water wheels, friction clutches and steam engines. Full dimensions and prices.

Brouhot & Cie., Vierzon, Cher., France.—

(a) Illustrated catalogue of steam engines, pumps and agricultural machinery; (b) price list of same; (c) catalogue of gas and oil engines, with testimonials. Illustrated.

Snowdon, Sons & Co., Limited, Millwall, London, E.—Large illustrated price list of a variety of lubricants and lubricators, prominent among which are the "Snowdrift" lubricant and the Berry-Snowdon automatic lubricators. Packings, non-conducting compositions, boiler fluids, etc., are also priced.

The Britannia Company, Colchester, England.—Cloth bound book, entitled "Screws and Screw-making," the first half of which is a treatise on screw-making in all its branches, while the second half illustrates and describes a full line of machine tools, engineers' hand tools, etc. Prices are given.

The Kingfisher Patent Manufacturing Company, Leeds, England.—Circulars describing (a) the Emissary electrical lubricant; (b) sight feed lubricators; (c) various lubricating specialties.

The Bristol Wagon and Carriage Works Company, Limited, Laurence Hill, Bristol, England.—Illustrated catalogue of carts, wagons, vans, etc., of all descriptions, for private, business and farming purposes. Prices are invariably attached.

William Johnson & Sons, Armley, Leeds, England.—Catalogues of brick and tile making machinery, elevating and conveying plant, grinders, separators, etc. Illustrated.

The Croft Foundry Company, Walsall, England.—Circular giving illustrations of special castings for the cycle and gun trades.

H. Munzing, 199 Upper Thames St., London.—Price list of radiators and apparatus for warming by steam or water; also of the Mercer sectional safety boiler.

Screw Boss Pulley Company, Limited, Thrapston, England.—(a) Price list of pulleys, shafting and mill accessories, among which is the Smith self-oiling plummer block; (b) pamphlet containing illustrated description of the firm's works.

William Summerscales & Sons, Limited, Coney Lane Works, Keighley, England.—(a) Laundry and cooking machinery catalogue, illustrating a full equipment for steam laundries, steam carpet beaters, bakers' ovens, stoves, etc.; (b) illustrated price list of wringing and mangling machines, sewing machines and miscellaneous agricultural plant; (c) folder price list of garden rollers.

Samuel Denison & Son, Hunslet Foundry, Leeds, England.—Illustrated price list of weighing machines, railway and road weigh-bridges; also of suspended weighers, wire testing machines, etc. Full data and dimensions are included.

The Kilbourn Patent Refrigerator Company, Limited, 23 Dublin St., Liverpool, England.—(a) Illustrated catalogue of refrigerating installations for cold storage, with lists of plant supplied; (b) catalogue of dairy refrigerating plants and other dairy appliances.

The Coil-Clutch and Pulley Company, Limited, Slough, Bucks, England.—(a) Series of illustrated circulars describing Lindsay's coil clutch and its applications to rolling mills, cranes, etc.; (b) copies of several testimonials from users.

THE
ENGINEERING MAGAZINE

VOL. XVII.

MAY, 1899.

NO. 2.

THE MONITOR, THE BATTLE-SHIP, THE CRUISER,
AND THE DESTROYER.

By G. W. Dickie.

HAVING treated, in the preceding paper, the heavier fighting units of the navy, it remains to discuss the lighter types—the cruiser and the destroyer. Both of these—unlike the monitor, which is almost distinctively American—are common to the navies of the world.

THE CRUISER.—Most navies have two types of cruisers, armored and protected. The armored cruiser in the great navies now equals the largest battle-ships in displacement, and in fighting qualities is not much behind them. At the same time, as already pointed out, the battle-ship proper has lengthened and become fine enough for eighteen or nineteen knots, and these very heavy ships will maintain their speed under conditions that would compel smaller ships to slow down. It does not appear necessary, therefore, to build a class of cruiser that is as expensive as a battle-ship, while not so strong either for offence or defence, and at best only two knots faster. I believe that the armored cruiser and the battle-ship will in the near future merge into each other, the result being a vessel having the best qualities of both.

I think that in action the new high-powered cruisers, fitted with water-tube boilers, will be in danger from the number of smoke pipes, usually four, the shooting down of any of which would interfere seriously with the working of guns and the ammunition service.

The protected cruiser seems to be the ideal vessel for cruising purposes. Experience indicates that these should be of two sizes,—say, of four thousand and six thousand tons' displacement. Of the latter



U. S. CRUISER OLYMPIA—5,800 TONS, 17,560 I.H.P.—DEWEY'S FLAG-SHIP.

size the Olympia is the only one in the United States navy. There are, however, a number of the former size, and some that are larger than the Olympia, the latter class including both armored and protected cruisers. I think, however, that the generally-expressed opinion of naval officers is in favor of six thousand tons for the larger class of protected cruiser, and four thousand for the smaller class, both to have a maximum speed of twenty-two knots.

TORPEDO-BOAT DESTROYER.—I have some doubt as to whether this type of vessel has been properly named. It depends upon the meaning attached to the word boat. If the meaning is a torpedo boat intended to destroy other torpedo boats, the name is not so terrible. But, if it means a torpedo boat whose business is destruction in general, then the name accounts for the dread that great war-ships have had of them. The United States had no boats of this class during the late war, and, although the Spanish had some that were considered very good, they evidently lacked the skill or courage to use them, so that nothing has been learned as to value, either for offence or defence, of this type of fighting machine. In a paper read before the Society of Naval Architects and Marine Engineers at the last annual meeting in New York, I endeavored to point out what, in my opinion, are the chief characteristics required in a sea-going torpedo-boat destroyer. That these vessels must be considered as sea-going is ad-

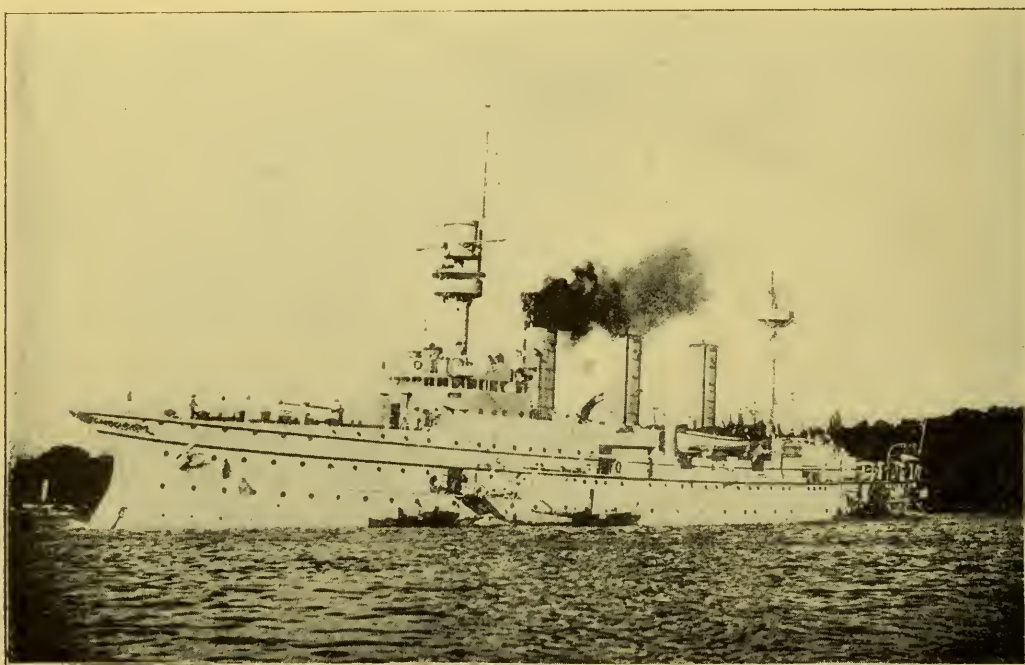
mitted, since the place assigned them in a naval expedition is with the attacking force, their duties being to guard against torpedo-boat attacks from shore, and to keep the large ships informed as to the whereabouts and evident intentions of the enemy. They must be able to do this in all kinds of weather, must have considerable fuel endurance, and must have more speed than protected cruisers. Can it be said that the present type of so-called torpedo-boat destroyers meets these requirements? A majority of these destroyers, when in



ITALIAN CRUISER CARLO ALBERTO, 6,500 TONS, 13,000 I.H.P.

good order, meet the requirements in the matter of speed for short distances in smooth water. But this one quality of speed has been made so paramount to all other qualities that the full speed can be reached only when the conditions are such that the sea-going qualities can be neglected.

If we consider the conditions of service for such a vessel, stationed on the Pacific coast of the United States, we find that, though these conditions do not differ in kind from those that prevail on the Atlantic



GERMAN CRUISER HERTHA, 5,650 TONS, 9,000 I.H.P.

seaboard, the adverse conditions are far greater. The great distance between harbors on the Pacific coast, and the almost constantly rough water along the coast from Point Conception on the south to Cape Flattery on the north, with only one harbor, render it necessary for any vessel, for practical service outside the harbor of San Francisco or the smooth waters of Puget Sound, to have good sea-going qualities and to be able to remain outside in all conditions of weather.

The qualities necessary for such a service are not possessed in any degree by the present torpedo-boat destroyers. While they have made voyages of considerable length at sea, they have done so usually under the care of a larger vessel, and, while doing so, they have needed extra care, both in watching the weather and taking advantage of every shelter that lies in the way. If the destination is reached without mishap, it is something to be proud of as an achievement en-



U. S. TORPEDO BOAT DESTROYER ROWAN, 276 TONS.

tirely outside of the service for which the vessel is fitted. During such movements these vessels have to be stripped of all their armament to render them possible.

Now, such a vessel in commission on the Pacific coast cannot go from San Francisco harbor to any other harbor without making an ocean voyage of several hundred miles, during which it probably will encounter rough weather.

The 420-ton destroyers lately ordered by the United States government are an improvement on the usual type, but we must go a good deal further in the same direction to obtain a vessel meeting all the conditions that such vessels must meet in sea service.

Recent acquirement of territory by the United States makes it necessary that such vessels for their navy shall have a much greater radius of action, and shall be treated differently. In fact, if a speed of thirty knots or more is aimed at, a sufficiently staunch sea-going vessel cannot be produced in the present state of the art. To obtain thirty knots with the boats now credited with that speed, a supreme effort under expert management is required, which is seldom repeated in the life of the boat.

If the thirty-knot torpedo-boat destroyer's machinery were more substantial, so that full power could be exerted at any time without risk, and if the hull were sufficiently strong to stand a moderate sea without danger, its speed would be about twenty-seven knots. Yet f

THE BATTLE-SHIP AND THE MONITOR.

venture to say that such a boat, if ordered to reach a point at sea, say, one hundred miles distant, would, under ordinary conditions, reach that point in less time than would be required by the regulation thirty-knot boat, which is said to get a horse power with less than fifty pounds of machinery.

Below I give specifications for a torpedo-boat destroyer adapted for sea service, and fit to accompany a fleet without being a source of care and anxiety to the large vessels. An outline sketch drawing is also given, showing how I would embody the necessary qualities in a sea-going vessel :

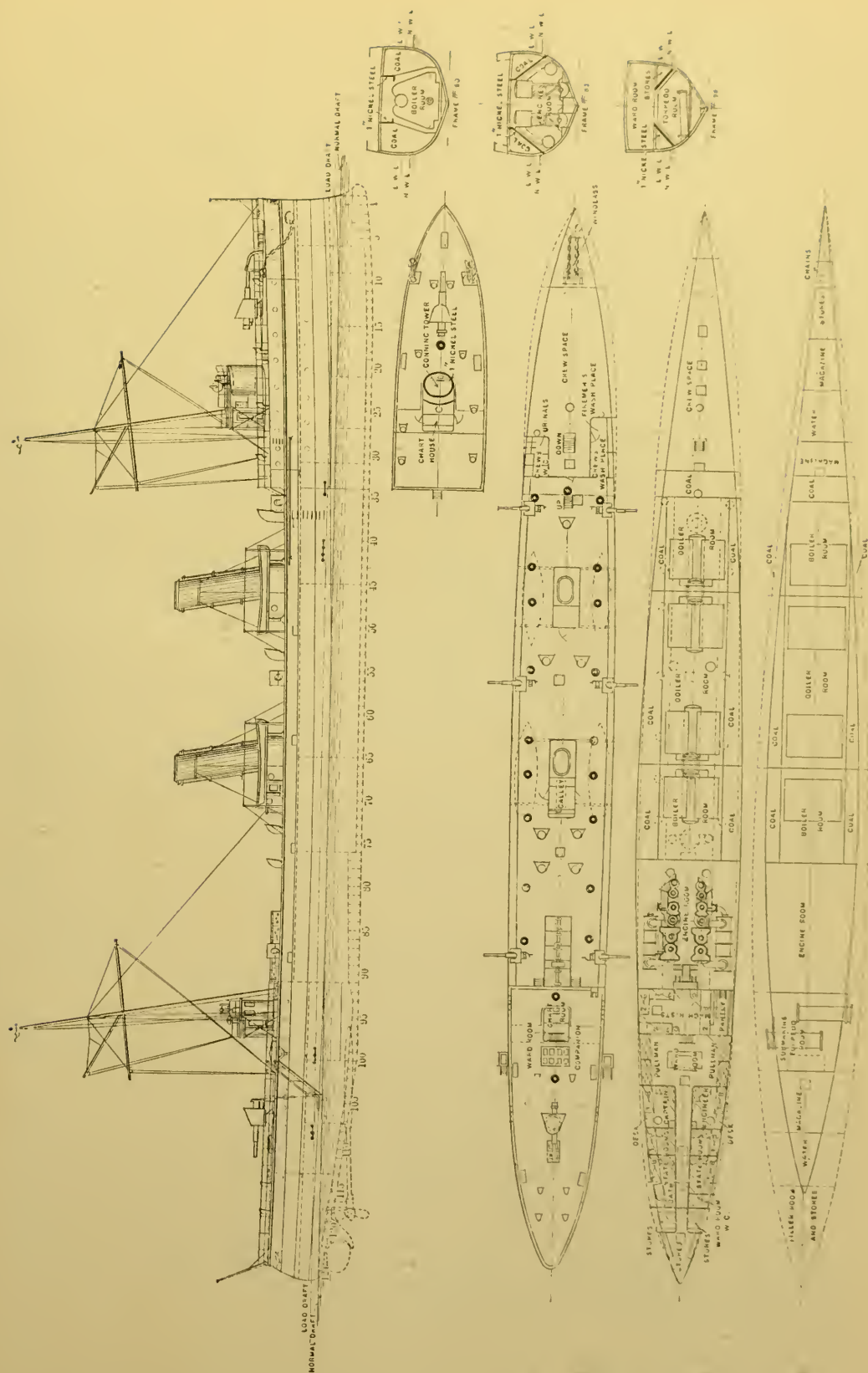
Length on normal water line.....	250 ft.
Extreme width.....	25 ft.
Depth moulded.....	15 ft.
Draught of water on trial.....	8 ft.
Draught of water loaded.....	9 ft. 5 ins.
Displacement on trial.....	640 tons.
Total displacement.....	800 tons.
Indicated horse power on trial.....	7,000
Speed on trial, average six hours.....	25 knots.
Radius of action at 12 knots.....	3,200 knots.
Speed possible from San Francisco to Honolulu.....	15 knots.
Speed possible from San Francisco to Puget Sound	
Naval Station or San Diego, moderate weather....	20 knots.

The weights provided for are as follows :

Ordnance	36 tons.
Machinery, including water in boilers, etc.....	230 tons.
Hull complete, and fittings.....	300 tons.
Crew and effects, including portable furniture.....	14 tons.
Coal at normal trim.....	60 tons.
Making the normal displacement.....	640 tons.
Coefficient at 8 ft. draught.....	.448

With bunkers full of coal, there would be 160 tons more, the full coal capacity being 200 tons.

I have designed this vessel with a full forecastle extending to the forward fire room and a half poop extending to the engine room. Between the poop and forecastle a hammock berthing extends the full length. This arrangement would give very good quarters, both for officers and crew. The vessel would carry two 4-inch rapid-firing guns, one on the forecastle deck and one on the poop. The 6-pounder guns, of which there are six, would be carried on rail mounts above the hammock berthing. Castings around the two smoke pipes are carried high enough to take the inner ends of the boat skid beams.



PROPOSED SEA-GOING TORPEDO BOAT DESTROYER.

This enables four boats to be carried, with head room under them, while the casings furnish room for the galleys on deck. The conning tower is of one-inch nickel steel. There is a chart house aft of the conning tower, and a bridge above. There is also an after steering house on the poop. This covers the stairs to the officers' quarters, and carries the search-light above. This light would be controlled from the forward bridge, although I believe that control from a distance for search-lights is not in so much favor now as it was formerly. The machinists, or engine-room artificers, as they are termed in England, would occupy a space at the forward end of the poop, entering from the landing leading to the engine room, aft of which would be the ward room and officers' state-rooms. The total complement of officers and crew would be seventy-five.

I have purposely omitted all deck torpedo-launching tubes, believing that they should form no part of the armament of a sea-going torpedo-boat destroyer. The deck tubes, if there was any intention to use them, would contain charged torpedoes, which, in action where many ships might be engaged, and in so exposed a position, would be a source of dread to those on board. I have therefore arranged for two special submerged torpedo tubes in a protected compartment aft of the engine room. Owing to the limited width of such a vessel, these tubes would be designed to open on top, instead of at the inner end. I believe that there is no mechanical difficulty in so designing discharging tubes and the impeller that carries the torpedo clear of the skin of the vessel before release, as to admit of the torpedo being placed in the tube from the top side.

The sloping sides of the torpedo room would be of one-inch nickel steel. One-inch nickel-steel protection extends also the whole length of the engine and boiler compartments, giving a moderate amount of protection when the coal bunkers are empty.

In this design I have aimed at a sea-going torpedo-boat destroyer that can go to sea and remain there, without any special risk, and can maintain there a speed of twenty-five knots for a few hours when such a speed is required; that can make extended voyages, thus serving the purpose of a scout or dispatch-boat whenever or wherever such service is required; and that carries a battery which makes her a torpedo-boat destroyer in fact. Such a boat would, I believe, meet the service conditions that will surely be demanded when the present type of boat has been put to the test of sea service.

THE POSSIBILITIES OF LIQUID AIR.

By Elihu Thomson.

AT the outset it must be understood that in dealing with the present subject the writer does not wish it to be inferred that what he calls possibilities are in his judgment probabilities of the near future, or, that we are upon the eve of any great revolution in engineering methods as the outcome of the recent laboratory studies of liquid air. Much further study and much additional data are required before anything more than mere suggestion can be made in this fascinating field; for, say what we may, the subject possesses an attraction for those who are accustomed to look ahead, remembering that the laboratory experiments of one day and generation have often in the past become the foundations of great industries. It took three-quarters of a century for Davy's electric arc to develop into the beginnings of commercial arc-lighting, and nearly fifty years elapsed after Faraday's brilliant researches in magneto-electricity before dynamos became a part of engineering. Yet Faraday had built a primitive dynamo and its reversed form was known in primitive types of electric motor.

Who would have supposed, when ammonia gas was first liquified by pressure, that before the close of the century companies would be doing business by sending it about in pipes for refrigeration? Yet such is the fact.

The splendid studies in liquid air and other gases carried on by Professors Dewar and Fleming, on the very spot where Faraday had made his memorable researches in the liquefaction of gases, form a fitting sequel to the work of that great pioneer.

The object of the present article will be to suggest rather than predict directions in which, under certain conditions, liquid air may possibly become a factor in engineering. And in the absence of favorable conditions need it be said that such possibilities will *not* be capable of realization?

Let us assume the availability of some innocuous gas liquefiable at about one hundred atmospheres pressure, at temperatures easily and cheaply attained, and at no cost for the gas itself. In such a case there can be no doubt of its soon finding enormous application in the storage and recovery of energy. Cheap power would be used to com-

press and liquefy it, after which it would be stored in quantity, either at atmospheric pressure or at some selected higher pressure. Such a liquefied gas would be stable, or remain in the liquid state, if heat were prevented from reaching it. This could be done, not perfectly of course, by surrounding the containing vessel with a liberal thickness of some good non-conductor of heat. That part of the gas which would inevitably escape on account of the lack of perfect heat-insulation would be cold and would be made to traverse the non-conducting covering in successive layers from within outward, and thus assist in cooling the covering and in preventing access of heat to the liquid; or, the escaping gas might even be made available for power in an engine, if the liquid were kept under a proper working-pressure. In this case further heating of the gas, analogous to superheating of steam, could be employed before sending it to the engine. But little of the energy of the heat so added would be lost, and a considerable part of it could be supplied by the surrounding air or by water.

With such a liquefied gas produced at one place by cheap power and carried to another for evaporation and recovery of power, ice could be made as a by-product.

In many plants used for the development of power on a large scale, a twenty-four hours' output is not called for, but could be attained at but slight additional expense. The excess power from such a plant needs some means of utilization. This excess power, as during periods of otherwise light load, could be employed to liquefy the assumed gas. On a large scale this procedure would not be costly, supposing the use of highly developed machinery. The liquid product could then be transported in tanks provided with heavy lagging and special arrangements to prevent access of heat from the outside. Perhaps it could be distributed by a well-covered pipe-line. The unavoidable evaporation which would be involved in the pipe-line transportation might not be altogether a loss, for if the line be under a pressure suitable for engines the escaping gas might possibly be tapped out at intervals, heated, and used for power along the line of way.

But the foregoing considerations are based upon the existence of a gas at no cost, with desirable properties rendering its liquefaction easy. Such a gas does not in fact exist. There then arises the question whether we can render available any of the gases known to us. Carbonic-acid gas is cheap, but still far too costly for use in the way proposed. It would not pay to send it back long distances for recom-

pression and reliquefaction. It costs too much to be thrown away after it has been once used.

The air itself meets the condition of no cost for material in the case. We owe much the larger part of our present knowledge of the properties of liquid air to a brilliant series of investigations undertaken some years ago by Professor Dewar at the Royal Institution in London, and continued later by Professors Dewar and Fleming conjointly. The effects of the exceedingly low temperature attained by the evaporation of liquid air, upon electric conductors, dielectrics, electrolytes, etc., have been carefully studied by them. Few are able to appreciate the labor and painstaking effort that must have been expended in these researches.

In culmination, Professor Dewar has indeed lately succeeded in reducing even hydrogen to a liquid and in collecting quantities of it. Temperatures not far removed from absolute zero (-273° C.) are obtained by the evaporation of liquid hydrogen. But the absolute zero, like the dynamo of 100 per cent. efficiency, may by each advance be more and more closely approximated but never reached. This low-temperature research has shown that at temperatures as low as -200° C., attainable by evaporation of liquid air, conducting-metals, as copper, platinum, silver, etc., when in a very pure state, have their conductivities so much enhanced that electric currents flow with but a fraction of the resistance experienced at ordinary temperatures. Research has shown that at absolute zero they would become perfect conductors. Professors Dewar and Fleming also found that liquid air is a very perfect insulator, and that ice and many frozen electrolytes even become excellent insulators at the temperatures of liquid air; and in general that intense cold in insulators improves the insulation, just as it improves the conductivity of conducting-metals when they are pure.

Unfortunately, however, the liquefaction of air requires rather extreme conditions, and in the early work of Dewar was an exceedingly costly process.

The discovery of the fact that air compressed, cooled, and collected in a reservoir at from 100 to 150 atmospheres might be made to liquefy a portion of its own volume, rendered possible the procuring of liquid air by a more direct and simple means. This discovery is claimed by several persons, the merits of whose claims will not be here discussed. When highly compressed air escapes from a suitable orifice it is cooled by its own expansion. If the cooled air be now caused to circulate around a long coiled pipe, which brings the compressed

air to the jet in such a way that the portion of pipe nearest the jet is the first to be met by the cooled air, and so back progressively from the jet; further, if the whole be thoroughly jacketed by a non-conducting covering, the temperature at the jet soon falls sufficiently low to cause liquefaction of a portion of the air even at ordinary atmospheric pressure. The operation itself is cumulative or self-intensifying, since the cooling due to expansion is employed, on the regenerator principle, to cool most effectively the compressed gas on its way to the jet and ready to expand.

If air be compressed to about 800 atmospheres it may be made to occupy the same space as it does when liquefied, but even at higher pressures it would remain gaseous. Ordinary temperatures of the surrounding air are far above the critical temperatures of the gases composing it. In order that it may liquefy, it must lose kinetic energy or be cooled; the velocity of the moving molecules must be brought down. The removal of heat is essential, and the process of liquefaction can only be carried on by cooling the gas during or after compression. Conversely, liquid air confined in a closed and filled receptacle, when allowed to regain the heat lost in being liquefied, would become gaseous and exert a pressure of about six tons per square inch.

That the processes for producing liquid air will be developed so as to reduce the cost to an extent such as to render it available in place of a more ideal gas would be a vain prediction to make at present.

Liquid air consists chiefly of a mixture of four parts of nitrogen to one of oxygen. The presence of the oxygen is a disadvantage, inasmuch as fierce combustion, if not explosion, may be occasioned by bringing liquid air into contact with combustibles in presence of a spark or fire. Fine cotton fibre and suchlike substances soaked in liquid oxygen are highly explosive. It is easy, however, to separate the oxygen from the nitrogen by fractional distillation at low temperatures, or methods may be employed to condense the oxygen separately from the nitrogen. Doubtless, oxygen gas so separated from its companion would have a value in chemical and metallurgical processes. The remaining nitrogen liquefied would be perfectly safe. Can it be transported?

The fact that a three-gallon milk-can of liquid air was brought by Mr. Tripler, of New York, from that city to Lynn, Mass., a journey occupying nine hours, and that not more than one third of the liquefied gas was lost, although the only covering for heat-insulation was about $2\frac{1}{2}$ inches of ordinary steam-pipe felting, goes far toward

indicating the possibility of transportation. With a tank of 20 times the linear dimensions of the milk-can referred to, the surface for loss of heat would rise to 400 times while the capacity would have increased to 8,000 times, and with no better lagging it is easily seen that the daily loss would then be not over 5 per cent. Doubtless, however, improved means for heat-insulation would make the loss but a fraction of this amount. If the tank were kept under a pressure of, say, 200 pounds to the square inch, a suitable safety-valve being provided to prevent excess of pressure, the evaporated gas or air could be made to do work, especially if superheated. If the tank were in a train the motive-power might, at least in part, be derived from the normal evaporation from the tanks. Further, let us imagine a pipe-line well insulated for heat, and it is easy to see that if the velocity of flow equalled the train-speed in the journey of the milk-can from New York to Lynn, the percentage loss in a pipe of the diameter of the milk-can with no better lagging than it possessed would be the same or even less. Here again perfection of heat-insulation might make quite a saving, and the evaporated gas might, if the line were under pressure, be made available for power along the line of way.

Whether the liquefied gases of the air can be employed in this way, will, however, depend upon the development of efficient methods of extracting the heat and effecting condensation of the air. That liquid air possesses no advantage for refrigeration is without doubt true, unless the refrigerating effect be obtainable as a by-product, so to speak, of energy conveyance.

Liquid air represents air compressed to about 800 atmospheres, but existing without pressure. No heavy and excessively strong tanks are needed for storing it. If it be pumped into a closed receptacle under regulated pressure it may be evaporated by the heat of the air, or that of surrounding objects, or it may receive heat from bodies undergoing refrigeration, as water being converted into ice; after which heating operation it may be further heated to the melting-point of lead by heat of combustion, and be finally used in a suitable engine where its expansion may develop power. During its expansion and delivery of power to the pistons of the engine it may become so cooled as to be discharged from the exhaust at nearly normal atmospheric temperature and pressure.

The power expended in compressing and liquefying air is, of course, converted into heat and thrown away. The product, liquid air, has no inherent power of energy in itself. It represents negativity, bearing somewhat the same relation that an exhausted globe does to the

surrounding air. It may become the means for rendering the normal energy in the surrounding air available. Liquid air has capacity for taking up the ordinary heat of surrounding objects and thus acquiring pressure. It can be superheated very efficiently, and so used in the form of compressed air in an engine. The superheating will, of course, tend to raise greatly the total efficiency. The inevitable losses in the compressing and liquefying processes would in part be made up in the added heat, the amount of which is small and efficiently employed. We have no reliable data of large-scale operations, and can as yet reach no certainty as to the efficiency attainable in compression and liquefaction or in recovery of power. It is possible that the separation of oxygen, which would probably possess a value in metallurgy, might tend to diminish the cost of condensation. So also the refrigeration which is obtained during evaporation might help the recovery end. Where so much is "in the air" we must be content with suggestions only, and they may never be realized in practice. The power required to be expended in liquefying a given amount of air can be approximately estimated, and an assumed efficiency of plant may be made to do duty in place of exact figures where none are to be had, and if the conclusions based thereon are understood as tentative and subject to extensive modification in view of further advances in our knowledge, no harm is done.

In making an estimate of the cost of liquid air as produced on the large scale, the factors of plant-efficiency, maintenance, etc., come in to a greater or less extent. Assuming that air be compressed as nearly isothermally as possible, and that in a large plant a possible total efficiency of seventy per cent. might probably be realized, each horsepower hour might thus be expected to compress nearly 10 pounds of air to a pressure of 2,000 pounds to the square inch. If such compressed air, on being expanded in a very carefully arranged self-intensifying apparatus should condense 25 per cent. of the air admitted we would have about $2\frac{1}{2}$ pounds of liquid air per horse-power hour. The assumed proportion, 25 per cent., seems not improbable in view of all the data—meagre enough, it is true—which have come to the writer's knowledge.

If the power-cost be taken at \$20 per year in large units and an additional charge of \$10 be allowed for each horse-power of the compressing and condensing plant, its interest, maintenance, and operating expenses, the cost per pound of liquid air would be about one sixth of a cent, assuming the plant to run 7,200 hours per year. This estimate, subject to modification from the very nature of the problem, would

make the liquid air cost for production about 8 cents per cubic foot. If oxygen, separated by fractional distillation possessed a value for equal amounts in excess of the cost of the air the remaining nitrogen would, of course, be producible at a lower figure.

It is probably within the possibilities that a cubic foot of liquid air or nitrogen, if allowed to heat from its surroundings and then be further heated to 200° C., could, in a high-pressure engine, yield about five horse-power hours. If at the same time the vaporization of the air were attended by useful refrigeration, as in making ice, the cost of recovery would diminish. Need it be said here, however, that even if the cost of horse-power of recovered energy much exceeded that which is indicated in the foregoing estimates or assumptions, a demand may still exist for a source of power having great compactness, freedom from nuisance, no heated nor noxious exhaust, and of unequalled controllability? The horseless-vehicle problem certainly presents us with an instance in point.

It would seem, however, that certain uses may be found for liquid air in which considerations of cost are not so important as is the ability to obtain the effects in view. In warfare, for example, the possession of highly concentrated energy-stores under control is very important. Liquid air can be rapidly converted into compressed air at six tons per square inch. This would probably be useful in the projection of high explosives. Compressed air is now used for propelling mobile torpedoes, or fish-torpedoes as they are called. Dirigible torpedoes either depend for power upon compressed air or the electric energy of a storage-battery. Compressed air requires high pressures and very strong and heavy containing-vessels. Liquid air can be stored without pressure or at low pressures, and can be evaporated at any desired pressure, while its bulk represents that of air under 800 atmospheres. A storage battery would probably be from five to ten times as heavy as liquid air in a receptacle, for equal available energy. But no storage-battery could be discharged at an equivalent rate.

Submarine boats and flying-machines may yet find use for liquid air. In the submarine boat it could be evaporated by the heat of the surrounding water, and after furnishing power it would ventilate the boat. Before its final discharge it could be burnt with oil in a fuel-engine for further power. We may find use for it in the flying-machine. For emergency work it could in evaporating cool the cylinders of a fuel-engine and yield power as a result. Moreover, control of the submergence of a boat could be effected by the use of liquid air, so easily gasified, to add to the displacement.

The great feature of the application of such a power as liquid air would be its emergency value. By this is meant the ability to obtain at will a sudden output far beyond the normal. Animal power notably possesses this emergency value, and the success of electric trolley systems largely depends upon the fact that, when needed, the station can be called upon for a temporary delivery to any single car or train, of a power greatly in excess of the rated output of the motors.

Suggestions have already been made of the use of liquid air or oxygen, mixed with combustibles as a high explosive. Such an explosive can be made at the time of use, and if left unexploded, either by accident or design, soon loses its dangerous character by evaporation of the liquid gas.

Liquid air may also be used in the rapid production of high vacua. Let the bulb to be exhausted be filled with a gas, such as carbonic acid, more condensible than air, and be provided with an extension that can at any time be sealed off. If now the extension-piece be immersed in liquid air the condensible gas will be taken from the bulb and deposited in the solid state in the extension-piece. This is now sealed off, leaving a high vacuum in the bulb, particularly if the same be heated during the process.

A fascinating speculation for the electrical engineer is the possibility of so cooling the conductors of electric lines or apparatus as to improve the conductivity many times, and so diminish the losses in any given length of conductor, and at the same time greatly improve the insulation. Professors Dewar and Fleming have shown, however, that it is a condition of this enormous improvement in conductivity that the metals be very pure, a very small percentage of impurity greatly lessening the result. As regards the insulation, they have shown that dielectrics, and even electrolytes become insulators of excellent character when cooled to the temperature of liquid air. What effect such a lowering of temperature would have upon the dielectric strength or striking distance between conductors at great differences of potential is not as yet determined, so far as the writer is aware. The result to be expected from a consideration of the effect of heating upon dielectric strength or striking distance is that very low temperature will make it far more difficult to break down insulation by sparking through it.

That the electrical engineer covets just such agencies as will thus extend the range of possibilities in his art needs no proof. He would be apt to choose a pipe-line conveying liquid air as the very best location for his conductors, assumed to be made of as pure metal as

possible, the high insulation probably attainable being the chief object. Whether his conductors were placed outside such a pipe or within the same, he could no doubt adapt himself to the conditions, provided he could get the benefit of the low temperature insulation, and possibly, to a certain extent, a gain in conduction.

It is indeed very questionable whether a pipe-line will ever be laid and kept filled with liquid air solely for its electrical benefits, but if such a line were also used to supply liquid air to a distant point and the normal evaporation utilized, the case would be somewhat modified, though the improbability of such a combination being put into service, at least within any reasonable period, still remains.

It will be the proper attitude for the conservative and at the same time progressive engineer to await the possession of full and accurate data before drawing any conclusions as to future practice. Suggestions of possibilities are, of course, useful, even if only a fraction of them prove realizable, and no attempt is here made to do otherwise than call attention to matters which must from their nature possess more or less of interest.

CENTRAL-STATION PRACTICE IN GREAT BRITAIN.

By H. Cuthbert Hall.

ELECTRIC lighting from central stations was removed from the domain of scientific speculation to practical politics by the invention of the high-resistance incandescent lamp, which was the outcome of the recognition of the principle that the distribution of electricity must be at constant potential, with lamps working in multiple arc.

Since the date of this invention (1880), lighting from central stations has progressed with great rapidity; but in England, perhaps more than in any other country of the world, restrictive legislation has acted as a deterrent to persons desirous of undertaking the public supply of electricity. The tendency of the legislature has been to impose conditions which primarily are for the protection of the public rather than as little restrictive as possible to a great industry enormously for the general advantage. The act of 1882, which gave local authorities the option to purchase at the end of twenty-one years the electric-lighting undertakings of public companies supplying current in their areas, by reason of this clause offered no special inducement to companies to put down a supply-station. At that time, when public lighting by means of electricity was still almost of an experimental nature, it was particularly desirable to encourage private, as opposed to municipal, enterprise. The lighting of private houses and small groups of buildings with electricity had been demonstrated not only an engineering, but a financial, success; but, although these plants provided engineering data on which to base calculations for central stations for the public supply of electricity for large areas, they afforded little or no criterion of the profit likely to be derived from such undertakings. The twenty-one years' clause having proved restrictive of private enterprise, in 1888 a bill was brought before parliament containing many important modifications of the previous bill, but principally a clause by which the limit of time for which the supply company could retain control of its undertaking, without the liability to be bought up by the municipality, was placed at forty-two years. The results of these important modifications were seen at once in a large number of applications from public companies to Parliament for the

right to supply electricity in the various towns and cities of the kingdom.

About 1895 two large companies were formed, each desiring to promote bills empowering them to supply current not to private consumers, but in bulk to supply-companies, which would distribute the current to the private consumers. These companies were, in a word, to be wholesale suppliers of electricity, supplying large quantities to a few big customers, rather than small quantities to numerous customers, as is the case with the ordinary supply-company.

All this is matter of history, but it is very important in showing the influence of legislation on electric lighting, or, to speak more accurately, as showing the central-station practice which experience has proved the best, and which has resulted in, or promises to result in, a special form of legislation.

Electric-lighting legislation in England generally may therefore be regarded as the outcome of expressed engineering experience. On the other hand, certain details of legislation make for the adoption of special methods of supply of electricity which are not in themselves inherently the most advantageous, but which may be necessitated by the course adopted by the legislature. Particularly is this the case with regard to the location of central stations outside the area to be supplied. The act of 1888, by giving statutory powers to electric supply-companies to acquire land compulsorily for the erection of central stations, has not exempted them from actions for damages to neighboring buildings from smoke, vibration, and other forms of nuisance. True, it has been laid down that, where such statutory powers have been conferred, the company can not be shown to have been guilty of nuisance, unless it be proved that it has not adopted reasonable means for the prevention of such a nuisance; but, practically, the operation of the act is that, where any engineering devices exist, which, however expensive, tend to reduction or elimination of the nuisance in question, the company which does not employ them is guilty of negligence. The practical outcome of this has been that in several cases (*e. g.*, the Chelsea Electric Supply Company), in order to eliminate vibration, the company was compelled, at great cost, to experiment with different types of engines, until that particular type which was found to give the least vibration had been arrived at. Certain broad principles on which the work should be carried out having received recognition by engineers in every part of the world, attention was devoted to perfecting the details of distribution. Perhaps in no other industrial enterprise is the development of power carried out on lines so highly sci-

entific, the profits of electric lighting being comparatively so meagre that all the details of the generation of power have been brought necessarily almost to perfection.

The experience of Manchester, where current is supplied at as low a rate as 3d. per unit; of Bradford, where it is supplied at 2d. per unit; and of London, where, from the City of London Lighting Company, current can be obtained for certain purposes for 3d. per unit, all demonstrate the high pitch of perfection to which engineering enterprise in connection with the supply of electricity has been brought.

It is not the purpose of this article to deal, in more than a cursory way, with the details of central-station engineering which have contributed to this end, but to discuss those general principles which promise substantial reduction in the cost of electricity in the near future.

Among what may be called the details of central-station engineering which, as experience has shown, materially reduce the cost of supply, principally by reducing the capital outlay, are: (1) the three-wire system; (2) high-speed engines; (3) 200-volt lamps. Early central stations were put down on one of two principles, either low-tension direct-current supply at 100 volts, or high-tension alternate-current supply, generating at 1,000 volts and transforming down to 100 at the consumers' lamps by means of transformers installed on the premises.

The first material advance was in the adoption of Dr. John Hopkinson's three-wire system, which enabled the supply-companies to effect a considerable saving in the cost of copper by doubling the potential at which current was supplied from the station, while it was kept at the same potential at the consumers' lamps.

Recently—in fact, during the last two or three years—the manufacture of incandescent lamps has so far advanced that the 200-volt lamp has passed from a laboratory curiosity to a commercial article, and, while the life of these lamps is still somewhat below that of the 100-volt lamps, the efficiency is greater, which, with the considerable reduction in the first cost of the lamps that has taken place during the last few years, represents an economy in current which may far more than compensate for the shorter life of the lamp and extra cost consequent on more frequent renewals. The introduction of the 200-volt lamp has enabled central stations to double their customers without further outlay for mains, and with very little further outlay for generating plant; so that, by the adoption of the three-wire system, twice as many lamps can be supplied as formerly with a given set of

mains and a given generating plant, and, by the adoption in addition of the 200-volt lamp, four times as many lamps as formerly.

The high-speed engine, although comparing very unfavourably with its low-speed brother as regards cost of maintenance and life, is, by reason of its compactness, and of the absence of connecting gear, cheaper, even in the long run, than the slow-speed horizontal type, and more particularly in those areas where the cost of land is high.

For the lighting of towns no point requires more careful consideration than the special conditions attaching to the town in question; therefore, reasoning from existing central stations in other towns having different conditions is often fallacious. Particularly is this the case with regard to some of the earlier central-lighting stations established in England. Although not universally, yet very generally, the earlier stations were established to serve towns representing the most favourable conditions, on the obvious principle of natural selection. Since that time, however, the details of the generation of electricity have been so much improved, and the particular system suited to a special area has been so well determined by experiment, that there is far more to be learned from the work carried out during the last few years, and more particularly in those towns where the conditions are by no means wholly favourable. Many towns in which electric lighting would have been ten years ago a failure from a pecuniary standpoint are now equipped with the central lighting-station plant, which not only gives an admirable service, but yields a handsome return on the capital invested.

Persons who have never studied the problems of electrical distribution, even engineers of high achievement in other branches of the profession, hardly realize how extremely onerous are the conditions under which the central lighting-station engineer has to do his work. In almost every other branch of engineering where power has to be developed the load is a practically constant factor, whereas the central lighting-station engineer has to provide plant for supplying a very large output for a very few hours of the twenty-four, while the plant which is to provide this output is, for the remaining hours of the day, practically idle and quite unremunerative. Therefore a comparatively small proportion of the plant has to earn a dividend on an amount of capital enormously in excess of that expended on what I may call the earning plant. Having regard to the fact that, despite this great difficulty, central stations which are earning dividends are very numerous, the prospects of the industry when a practically constant load can be obtained are enormous.

It has been suggested that the working of electric-traction systems in conjunction with lighting will solve this difficulty of the load factor. A little reflection, however, will serve to show that this idea is to a large extent fallacious—first, because the traction load overlaps at a certain time the lighting load, and, secondly, because the sudden demand on the plant for lighting purposes, as a result of fog in large cities, is in no way assisted by a constant load during the daytime for traction purposes. Engineers have, therefore, to recognise this fact, that, until the lighting load of a central station represents a very small proportion—almost a negligible proportion—of the total output of current from the station, the load factor can never be a good one. It is of the very nature of lighting that the demand should be constantly varying throughout the twenty-four hours, and liable to change in a few minutes from maximum to minimum load.

A reference to the load curves of any of the large central stations in the different towns of England and America would at once demonstrate the correctness of this statement. As, therefore, the time is yet a long way off when the constant demand on central stations for a current for power purposes will be enormously in excess of the demand for lighting purposes, central-station engineers have to grapple with the conditions which I have indicated above, and which are so onerous upon the undertaking.

We should not, however, in designing a central station for a large town, lose sight of the possibility of a great demand for current arising during the day-time for power purposes, as these are the conditions which in the near future may exist which will enable the greatest revenue to be earned upon central-station plant, and which should be borne in mind with a view to making the original plant of such a nature that it can be economically included with the plant intended to serve different and more remunerative conditions of working.

When a central supply-company is found sufficiently enterprising to put down in, or contiguous to, a large industrial centre a station avowedly for the supply of current for industrial purposes on a large scale at a low price, an enormous demand will be thereby created; and a far-seeing engineer will make it his business to create a demand by providing cheap supply. It has not been sufficiently realised that the supply of current for electric-lighting purposes on the cheapest possible lines is dependent upon making the lighting an adjunct of the supplying current for power purposes, and not the primary object.

Hardly too strongly can be urged the necessity of employing, in

connection with town lighting, a competent and absolutely independent consulting engineer; and, unless recourse be had to the practice which, in one or two isolated instances, has been adopted in Germany—of building the works at the expense of the town, with a contractor's guaranty of interest and depreciation—the construction of a central station, if left solely to the contractors, is likely to be on lines which, at best, would show a profit only for a short time, and will hardly ever be of such a character that advantageous extensions can be made. Nearly all contractors have their special apparatus to sell and advocate, and it is only human nature for each to think that his is best suited for every condition. In central stations carried out on such lines the apparatus which the contractor has to supply is first thought of, and it is fitted in as well as it can be to the particular conditions obtaining; whereas, of course, the conditions should be first considered, and that apparatus selected which is best suited to them.

A point that has to be very carefully considered is the particular system best suited to that part of the area to be supplied from which a dividend may reasonably be expected. Given an area comprising a number of houses situated close together and a smaller number of houses in outlying places, it will be better to put down a system perfectly suited to supplying the thickly-populated district, with a special plant for the outlying districts, than to have a uniform type of plant for the whole area. For, if the highest profit which it is possible to earn from the thickly-populated district be secured, this part will pay for the less profitable outlying districts, and, in fact, compensate for a possible loss in these districts.

A great point to be borne in mind is the impossibility of separating first-cost from working-cost. The initial outlay on one type of plant may be very much higher than on another, but, owing to its adoption, the low working-cost may more than compensate for the interest on the extra capital outlay. On the other hand, the working-cost with mains of a large diameter may be less than the working-cost with mains of a smaller diameter, but the interest on the capital outlay necessary for the larger-size mains may be greater than the saving in working-cost effected by using them. Water-power costing nothing per horse-power appears a much cheaper fuel than coal at 15s. a ton, but if, in order to utilize the water-power, it is necessary to put down mains of great length, costing many thousands of pounds, the interest on the capital outlay in connection with these mains will represent far more than the cost of fuel at 15s. a ton burned at works

in close proximity to the area throughout which current is distributed.

Although, as a general rule, so far as economy is concerned, it is desirable to have the central station as near the centre of the area of supply as possible, special conditions may obtain which justify, and even render desirable, the placing of the station some distance from the centre of supply. At Cheltenham, for instance, the works, which are a municipal concern, are placed about a mile and a half from the centre of the town. This site was adopted because the refuse-destructor is situated in this position, the land is owned by the corporation, and a chimney-stack used for the destructor can be also utilized for the electric-light works. Also, the Midland Railway Company passes so close to the site that coal can be conveyed to the works without carting and unloading. The shaft for the refuse-destructor being already constructed, and there being a 70-h. p. boiler already available, the cost of the works has been kept exceedingly low. As I have said above, where immediate economy alone is considered, it is usually desirable to place the central station as near to the centre of the area of supply as possible. But I feel confident that a time will arrive when central stations will be placed further from the centres of towns, many causes operating toward this end.

The great problem, therefore, which is likely to confront central-station engineers in the near future—one which may influence a radical change in all kinds of central-station plant and an almost complete alteration in existing methods of distribution and generation—is that which I have indicated above, *viz.*, the tendency to put down in certain favourable districts large central stations to supply electricity in bulk; and probably the principal question, in connection with the distribution of electricity, which the near future will solve will be whether it is cheaper to put down a number of isolated central stations in the particular areas to be supplied, or to put down fewer, and very much larger, stations in certain favourable places to supply the current in bulk to distributing stations situated in the centre of the areas which they supply. The advantages of this system of supply in bulk can be seen almost at a glance. In the first place, the difficulty of a good load factor will be thereby partially overcome, for current can be generated for industrial purposes at such a price that there will be a considerable demand. The stations will be put down in places where land is comparatively cheap, and far removed from buildings to which they are likely, by reason of smoke, vibration, or other causes, to constitute a nuisance. In the case of the scheme for

the Midlands, the station would be very favourably situated with regard to the supply of coal. It has been pointed out—and there is no gainsaying the fact—that the cost of carting coal is so low that it is very questionable whether energy can not be conveyed more cheaply in this form than by means of electricity generated in places where coal is very cheap. Certainly this principle applies to the generation of electricity generated by means of water-power; the interest on the capital outlay may be so high as to more than out-balance the advantages of cheap fuel; but, in the case referred to above, the station would be placed not so very far from a considerable number of large towns having extensive manufacturing interests, where demands for improved hygienic conditions are peculiarly exigent. By placing these large stations for the supply of electricity in bulk outside the residential and manufacturing centres, the difficulties which existing central stations in the area of supply now find so serious—*viz.*, actions for nuisances in respect of vibration, smoke, and other causes—would be eliminated, for the existing supply-stations would be converted from stations generating electricity by means of steam to mere distributing stations having only electric motors and dynamos, involving no smoke, and reducing vibration to the minimum obtainable with running machinery.

Certain of the companies, particularly in the west end of London, have found, during the last few years, that the demand for current was going up so rapidly, notwithstanding the introduction of the most economical methods of supply, that shortly their stations will be inadequate. Many of them state that they have been making strenuous efforts, during the last two or three years, to obtain suitable sites for the building of new stations, and most of them also report that these efforts have so far met with but very little success. In fact, in one case they have met with worse than want of success—with positive loss—for the station of at least one supply-company has been actually closed because it constituted a nuisance to neighboring buildings. Again, in the west end of London the mere question of getting coal carted to the station is a very important one. One station alone requires for its daily consumption of coal no fewer than two hundred carts. Two hundred carts carrying coal through west-end thoroughfares every day of the year constitute, unless the traffic is relegated to special hours of the day, a serious nuisance, and when we reflect that this difficulty, rather than decreasing, is daily tending to increase, a case for supply-stations outside the area of distribution daily becomes stronger.

THE CONSTRUCTION OF THE ALEXANDER III. BRIDGE, PARIS.

By Jacques Boyer.

THE Alexander III. Bridge,* now in course of construction between the Champs Elysées and the Esplanade des Invalides, will be one of the most remarkable of the bridges over the Seine at Paris. Begun in 1895, the first project for the construction of the bridge underwent many important alterations, which now possess only retrospective interest; but, without going into the details of the engineering discussions on the subject, it will be well to indicate here the general conditions of the problem which its erection presented.

It was necessary that the bridge should suffice for the needs of both the navigation of the Seine and the circulation of the city, while at the same time satisfying certain æsthetic desiderata. As it is to be a part of the Exposition of 1900, it was needful that it should be decorative in character, at least to the extent that it would neither injure the appearance of the river nor obstruct the view of the Invalides from the Champs Elysées. Its width had to be sufficient to harmonise with its vast approaches on the two sides. In addition, this structure, situated below a bend of the river which throws the main current over toward the right bank, and only a short distance above the Pont des Invalides (see Fig. 2), is badly placed as regards the navigation of tows in the stream. It was, then, indispensable to construct the bridge without an intermediate pier, lighters and barges being difficult to steer in passing the arches of bridges with many piers. Furthermore, it was requisite that the fairway under the bridge should be wide enough to allow the straightening of tows of barges coming down the river and preparing to shoot the arches of the Pont des Invalides, this being necessitated by the deflection of the current toward the right bank, as mentioned above.

As these two conditions did not entirely harmonise with the artistic desiderata, the Gordian knot was cut by the adoption of the solution least hurtful to the interests of navigation. It was decided

* The present Emperor of Russia laid the first stone of the bridge on October 7, 1896, naming the bridge in remembrance of his father, Alexander III.

to build a bridge of a single, very flat arch, of which the level above the water should be as high as the laws of perspective permit. It was consequently designed so as to bring the roadway to such a height that an observer, situated in the prolongation of the axis of the bridge on the right bank, might just be able to see the base of the Hotel des Invalides over the rise of the bridge. The above various considerations were among those guiding MM. Résal and Alby, the engineers who furnished the plans definitely approved by the administration in January and July, 1897. It may be said here that the administration has sacrificed more to art than to navigation, reserving, for the time, the correction of certain practical inconveniences created by the situation.

Before going into the details of construction, it is well to have a general idea of the future bridge. It is of the three-hinged arch type (see Fig. 3), the total length of the bridge between the two abutments being 109 metres (357 feet). Its longitudinal axis coincides with that of the new avenue which will lead from the Champs Elysées to the Esplanade des Invalides, crossing the Seine almost at a right angle; or, more exactly, $83^{\circ} 38'$ (see Fig. 4). The parapets of the two banks of the river are 155 metres apart, the two approaches being each 22.5 metres long. No other bridge in France is constructed with such flat arches. The resistance and elasticity of steel have allowed it to be given a remarkable coefficient of rise, as the table below will show.

COMPARISON OF RISE OF SOME FRENCH BRIDGES.

(All dimensions in metres)

Name.	Opening.	Rise.	Ratio of rise to span.
Alexander III., single arch (Paris)	107.5	6.28	$\frac{1}{17.12}$
Pont Mirabeau, central arch (Paris)	99.34	6.19	$\frac{1}{16.05}$
Pont Morand (Lyon)	central arch	4.44	$\frac{1}{15.18}$
	side arch	3.96	$\frac{1}{15.90}$
	side arch	3.70	$\frac{1}{13.00}$
Pont Boieldieu (Rouen)	central arch	2.50	$\frac{1}{16.00}$
	side arch	4.87	$\frac{1}{11.00}$

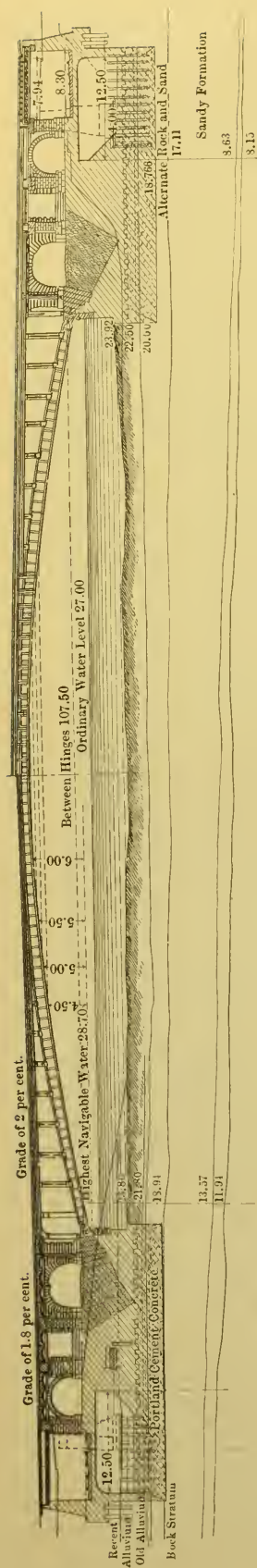


FIG. 3. LONGITUDINAL SECTION OF THE ALEXANDER III. BRIDGE.

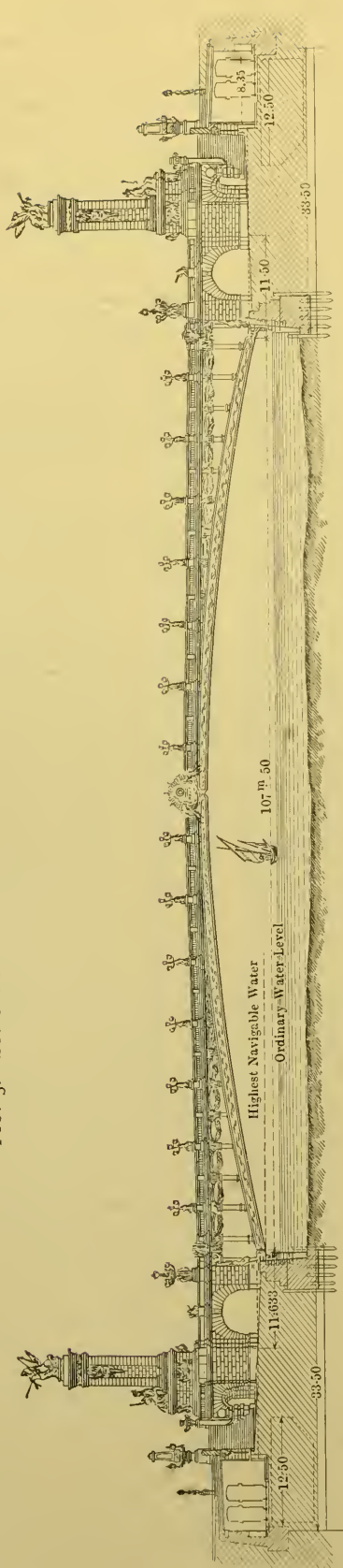


FIG. 1. GENERAL ELEVATION OF THE ALEXANDER III. BRIDGE.

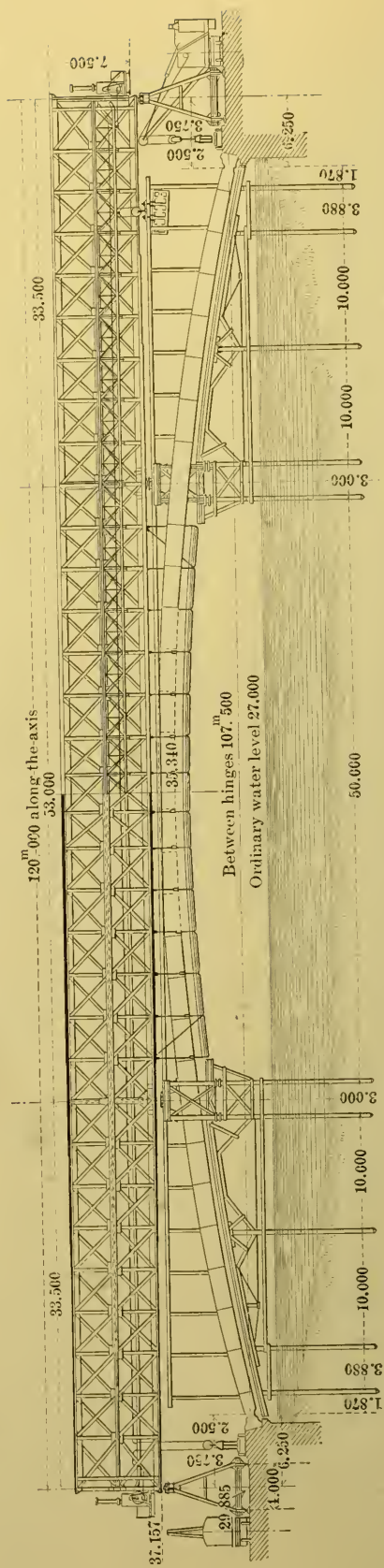
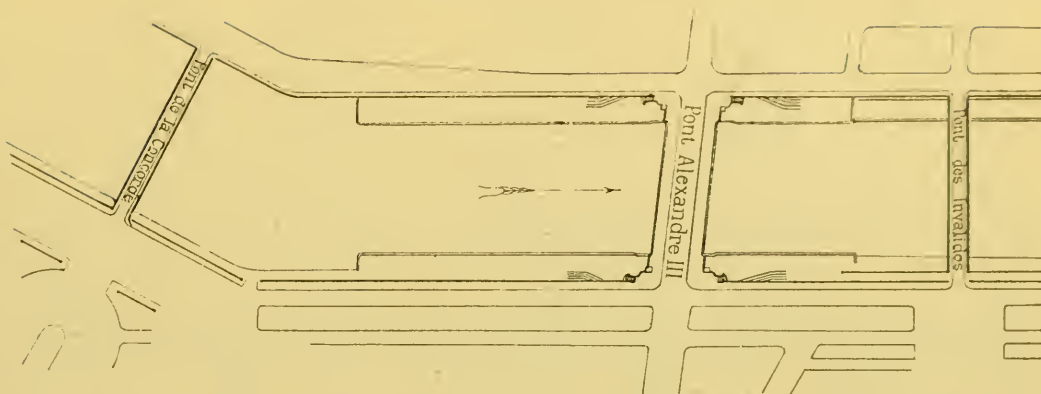


FIG. 13. SEMI-ELEVATION AND SECTION, SHOWING FALSE-WORKS.



The flooring of the bridge rests, through the intermediary of vertical pieces, upon fifteen arches of cast steel, articulated in sockets at their springings. The triple articulation, assuring a proper transmission of pressures, renders the stability of the structure independent of temperature, and thus diminishes to a great extent moments of flexure in the neighborhood of the key. In this way the arches are subjected only to compression stresses.

On account of the flatness of the arches the abutments of the

THE ALEXANDER III. BRIDGE.

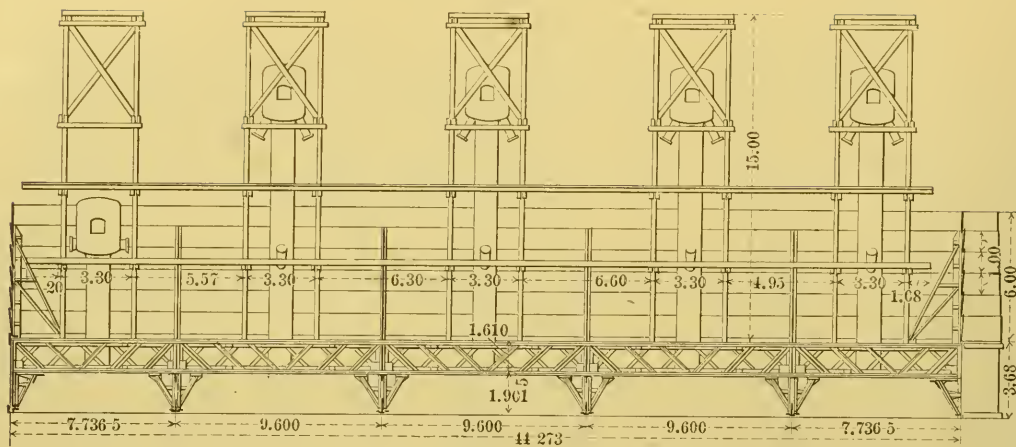


FIG. 5. LONGITUDINAL SECTION OF THE CAISSON AND SCAFFOLDING.

bridge will have to resist enormous stresses, to reduce which as much as possible, the metallic skeleton of the arches has been made as light as practicable and the dead weight of the flooring reduced by the use of high-quality material. As the springing articulations could not be placed lower than 2.25 metres above mean water-level, those at the key were carried to a height of 8.53 metres above the

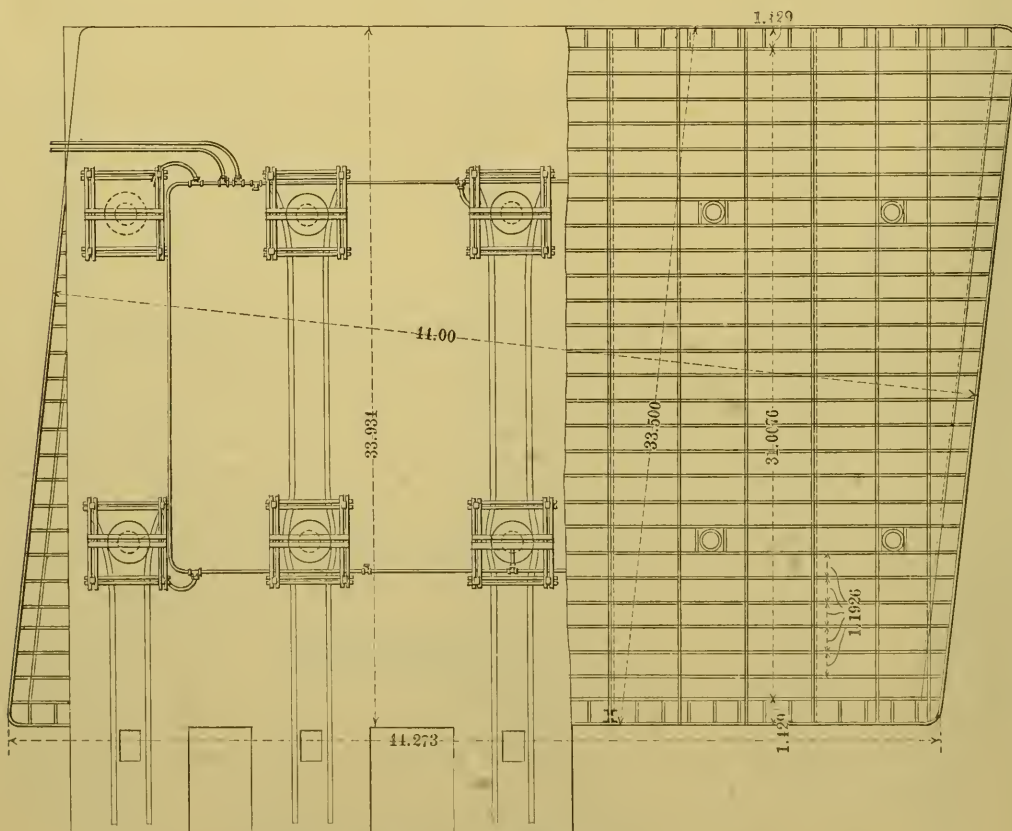


FIG. 6. PLAN OF CAISSON AND SCAFFOLDING.

same level, thus giving a very good headway under the bridge even at times of high water.

The Alexander III. Bridge will be the widest in the world, having a roadway of 20 metres width, on each side of which will be sidewalks 10 metres wide. The Austerlitz Bridge, in Paris, widened in 1884, is only 30 metres wide between its guard-rails, and the New York-Brooklyn Bridge only 25.5 metres wide. At each end of the new bridge the sidewalks are widened to give room for stairways leading to the quay level below. The terminal viaducts are pierced by several arches on each side of the Seine. The first allows of a passageway on the quay level, while two others connect with

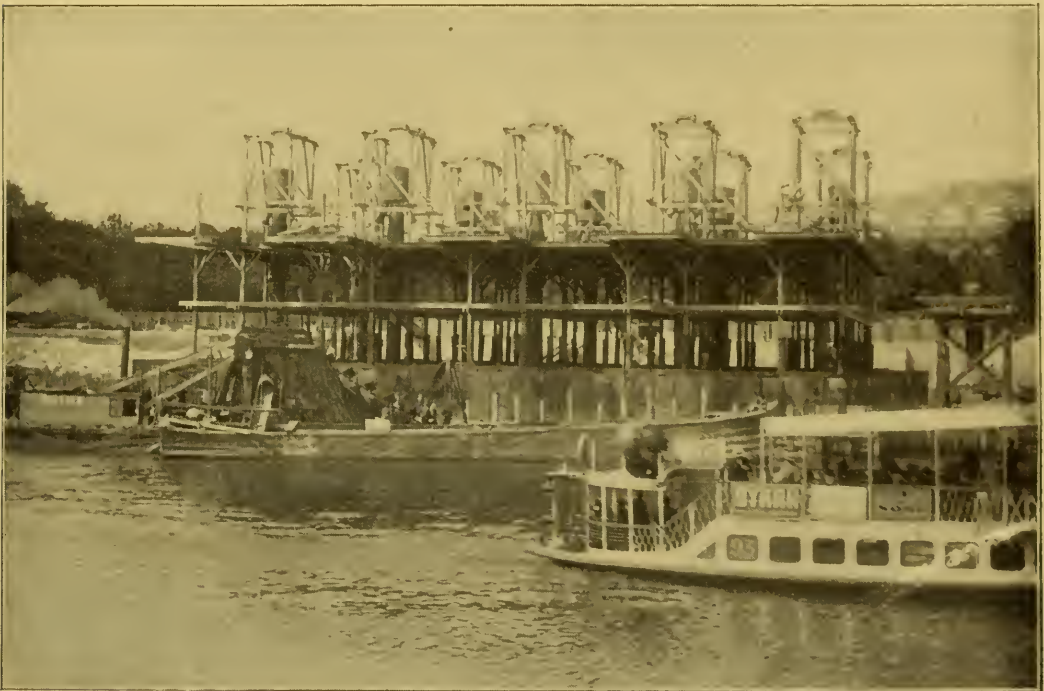


FIG. 7. THE CAISSON ON THE LEFT BANK DURING THE SINKING (SEPTEMBER, 1897).

the body of the masonry terminals on the banks. On account of the provisional shifting of the public highways of the city during the Exposition, covered ways are carried around behind the abutments.

After the adoption of the general plans, soundings were made for samples of the subsoil, in order to fix, from the data thus secured, upon proper conditions of stability for the abutments. It was decided to make the abutments so heavy that they would resist the thrust of the arch by their friction upon their foundations rather than by the backing of a retaining bank of earth. For this reason

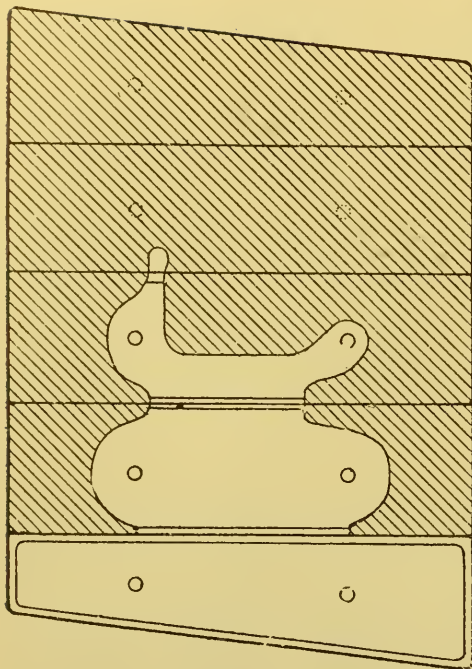


FIG. 8. METHOD OF FILLING CAISSONS.

The upper chamber is full, the second just filled; the others show the successive stages.

it was necessary to carry back the heel of the abutments, and to give them a footing of more than 20 metres. These works form, with the quay walls, a single piece of solid masonry, and, to bring their centres of gravity as near as possible to the curbing of the quays, they have been left hollow at their rear portions.

Each abutment is in the form of a parallelogram, of which the side along the axis of the bridge measures 33.5 metres. Their bases are masses of concrete 3.50 metres thick, composed of a mixture of three volumes of pebbles and two of mortar, the latter being made of 450 kilogrammes of Portland cement to one cubic metre



FIG. 9. THE PIER ON THE LEFT BANK DURING CONSTRUCTION (APRIL, 1898).

The dome of the Invalides is seen in the distance

of sand. To make a secure bond between this concrete and the masonry backing, the face in contact with the latter has been channelled with grooves. The upper part of the abutment is built of heavy stones laid in cement mortar. Their faces, on the river side, are of ashlar below and of Vosges granite above. The latter portion is composed of three courses of 0.5 metres each and a moulded string-piece, above which is the foundation for the sockets of arch-hinges. Four granite courses are also placed behind each of the sockets, perpendicular to the direction of the thrust, the surface of each increasing in size as it approaches the central part of the structure. By this means the thrust is better distributed over the ordinary masonry, which can only support a crushing stress of about 18 kilogrammes per square centimetre, while the granite pillow-blocks under the sockets can resist 48 kilogrammes.

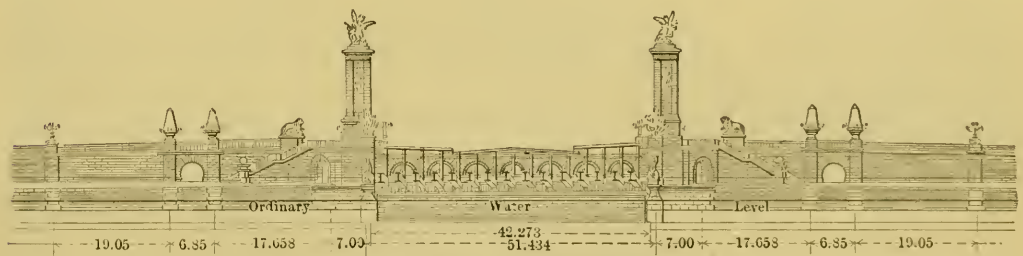


FIG. 10. TRANSVERSE SECTION OF THE ALEXANDER III. BRIDGE.

The contract for this work was let to MM. Letellier and BOUTRINQUIEU, who used pneumatic caissons for the submarine work.

The length of the caissons, parallel to the course of the river, is 44 metres, and their width 33.5 metres, the surface of their bases being thus 1,484 square metres. The caisson proper is a sheet-steel cell 5 millimetres thick and 3.68 metres high. Its roof, which is designed to form a water-tight diving-bell when the edges of the partitions of the caisson are under water, is divided into two parts—a lower working-room 1.90 metres in height, and an upper level, forming a sort of tray in which is laid the masonry that is to carry down the caisson by its weight and afterward support the abutment. Since the metallic roof of the caisson could not alone support such a weight, the working-space was cut up into five sections by four partitions forming supporting girders, these being furnished at the bottom with knife-edges of mild steel. Angle-brackets around the sides of the structure help to sustain the walls of the caisson and the partitions are cross-braced to each other. On the upper surface of the roof of the caisson a series of 27 beams was laid at right angles to those just described.

THE ALEXANDER III. BRIDGE.



FIG. 11. STATE OF THE PYLON ON THE RIGHT BANK, FROM ABOVE. (FEB., 1899.)

Each of the five subdivisions of the lower part has two entrance-wells, provided with air-locks. In order to gain time the contractors constructed these wells of the total length that would be required at the time of beginning, instead of extending them as the caisson sank to its bearings. This arrangement made it necessary to build a scaffold 7.20 metres high about the work for the use of the Decauville

wagons, used to transport the excavated materials from the air-locks to scows moored in the river near by. A lower level of scaffolding, at the height of the upper part of the finished structure, is devoted to the masonry work. In this way the work of excavation and construction goes on continually, neither interfering with the other.

The caissons were rapidly sunk. The contractors received orders to commence work on April 19, 1897. On the left bank the first operations of construction commenced on May 28, and on August 11 concrete was laid on the roof of the caisson. During the sinking of the caisson great precautions were taken to insure regularity and to avoid any flexure of the metallic structure. The sinking was finished, without accident, on the right bank on November 7. In order to avoid interference the entire force in the caisson worked alternately at digging and at removing the excavated material. Among the other difficulties encountered were those due to the variable resistance of the soil and the increasing friction of the adjacent earth as the caisson sank more deeply.

When the caisson reached the proper depth, the surface beneath it, consisting of a sort of calcareous flagstone, was cleaned and levelled and treated to a coat of neat cement mortar, upon which the concrete

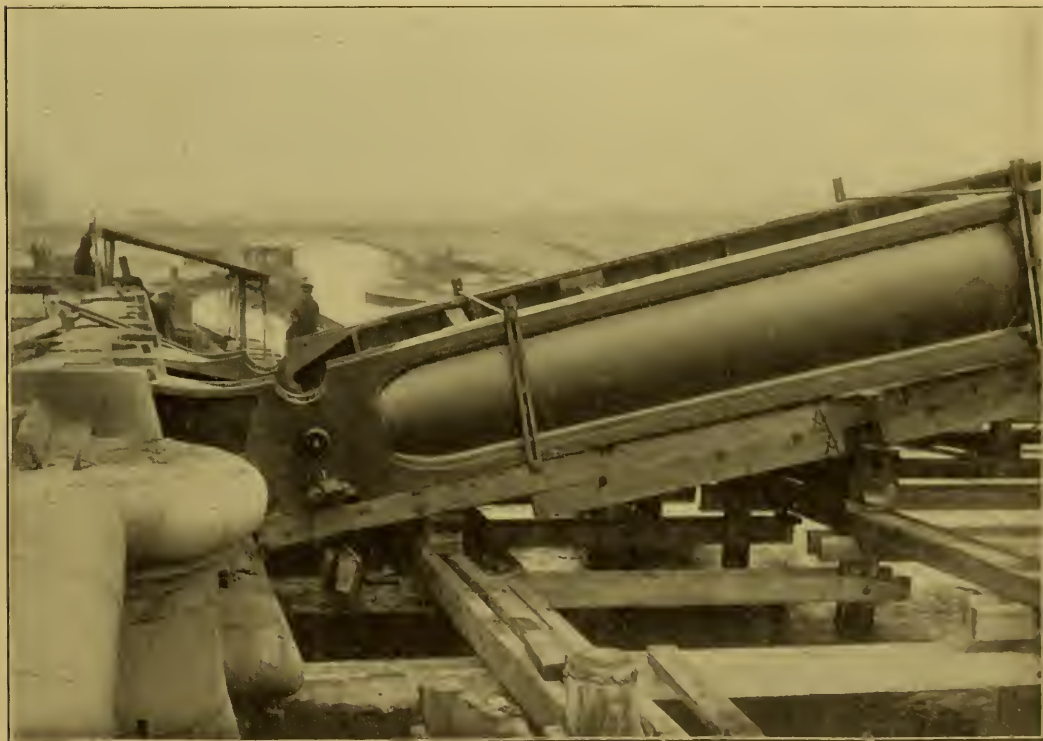


FIG. 12. A TERMINAL VOUSOIR, SHOWING HINGE AND BEARING ON THE PIER.



FIG. 14. ONE OF THE SUPPORTS OF THE FALSE-WORK TRUSS.

In the foreground an arch-voussoir is being handled, and the masons are dressing the granite face of the pier.

was filled in. The successive chambers of the caisson were filled in the manner shown schematically in Fig. 8, the men retreating from one to another as the work progressed. This ingenious arrangement allowed the electric lighting of the workings to be maintained to the end. To finish the work, by filling the air-lock wells, it was, of course,

necessary that the part below should be thoroughly water-tight. This was successfully accomplished by running in a stream of thin, neat, cement mortar. When this was set, a circular wooden plug, tightened in place by wedges, was inserted, and a further run of the cement mortar flowed in until the air-lock shafts were full to a point 0.60 metres below the bolts holding the upper part to the roof of the caisson. When the last shaft was filled the perfect tightness of the work was noted by the rapid fall in the consumption of compressed air. To make sure, however, that there should be no infiltration of water and washing out of concrete the pressure was kept on for 48 hours after the last mortar had been flowed in.

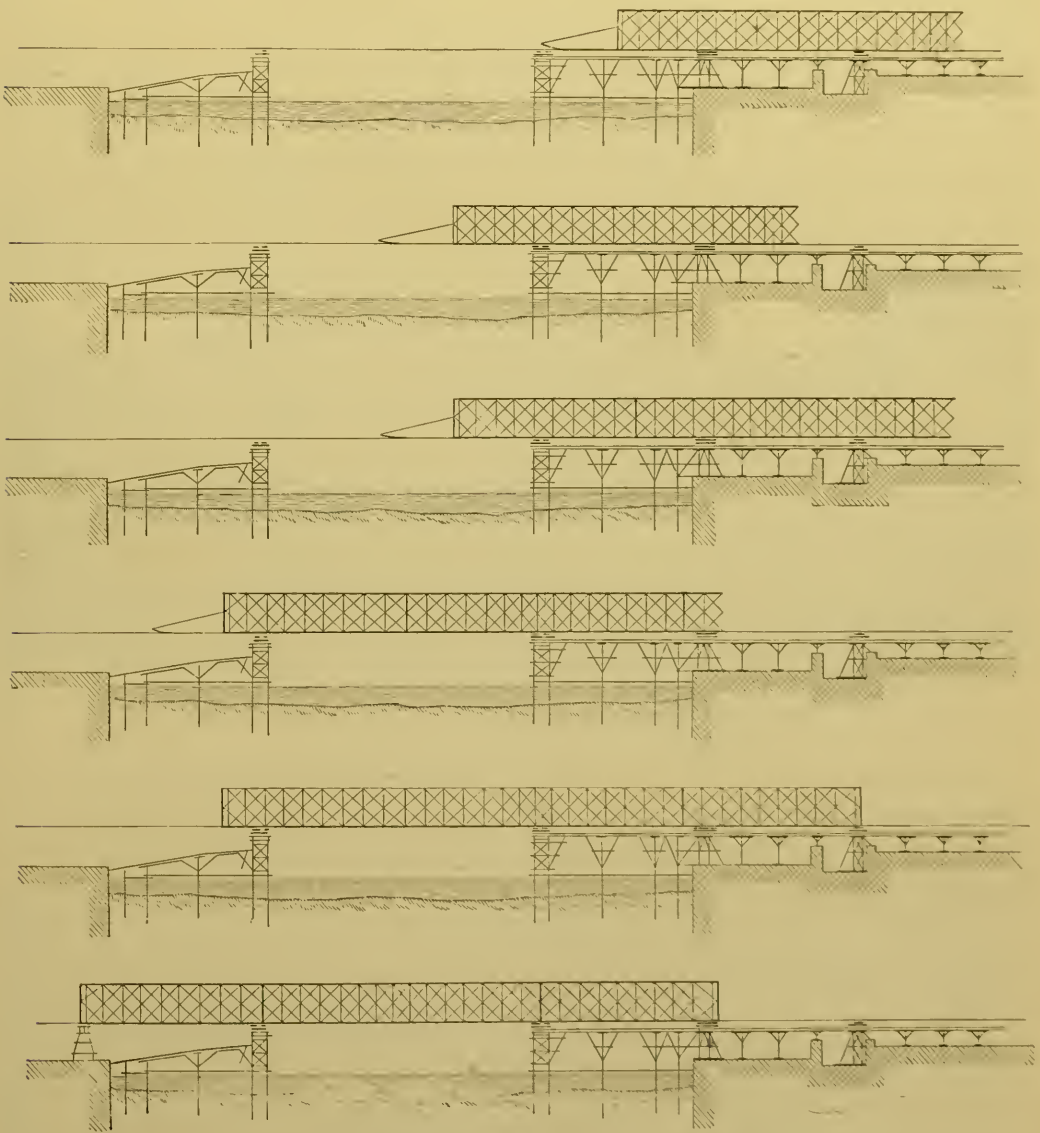


FIG. 15. THE ERECTION OF THE FALSE-WORKS.

Showing the manner in which the truss was constructed and launched, without interrupting navigation.

Compressed air was furnished to the workings by the Compagnie Parisienne Victor Popp, through a special pipe laid from the main passing over the Pont de la Concorde. After passing through a meter, one of which was installed at each working, the air was reduced to the pressure necessary for the caissons. The distribution-pipe was led around the upper-level scaffold, branches containing cocks leading to each of the chambers below. Electric lighting was supplied from an isolated plant, consisting of two vertical Raworth engines of 25 horse-power, direct-coupled to continuous-current dynamos. The mean daily consumption of current was 200 kilowatt hours, of which

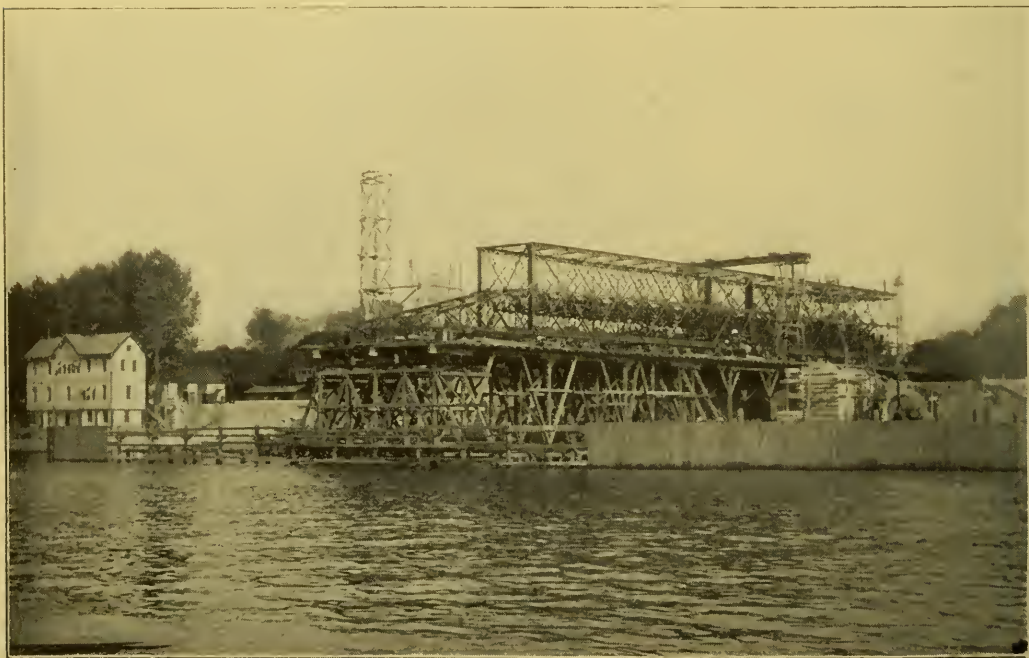


FIG. 16. THE FALSE-WORK TRUSS BEFORE LAUNCHING. (AUGUST, 1898.)

The engineer's office is seen on the left.

150 were consumed in the caissons by the 160 lamps they contained. Forty 50-c. p. lamps, grouped in sets of four, were used for exterior lighting.

On November 9, 1897, the scaffolds and upper parts of the air-lock wells were removed. On the right bank the work under compressed air lasted 79 days, on the left bank only 71 days, and this with an interruption of three days caused by fear of a freshet.

Passing now to the superstructures of the abutments, there is nothing especially noteworthy about the work of construction now under way upon them. Certain parts of this work can not be finished until all the metallic parts of the bridge are completed and the false-



FIG. 17. THE FALSE-WORK TRUSS AT THE SECOND STAGE OF THE LAUNCHING.
SEPTEMBER 8, 1898.

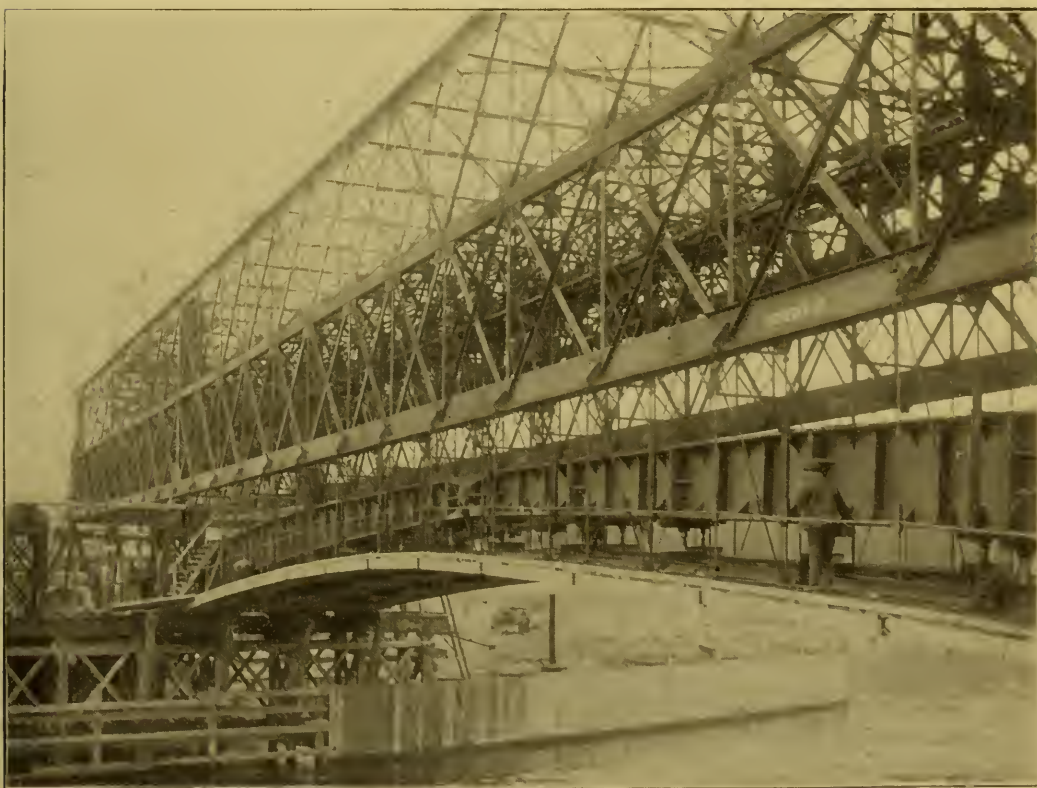


FIG. 18. ERECTION OF THE FIRST TWO ARCHES, CLOSE OF 1898.



FIG. 19. A GENERAL VIEW OF THE ALEXANDER III. BRIDGE. PHOTOGRAPHED FROM BELOW ON THE LEFT BANK, FEBRUARY, 1899.

Pont de la Concorde in the distance, Palace of Fine Arts of the Exposition on the left.

work removed. The following description of the superstructure was furnished by MM. Résal and Alby, to whom the writer wishes to express his thanks.

The arrangement of the arches above the platform is the same on both sides of the river. (See Figs. 3, 4, and 10.) Above the quay the platform of the bridge is formed of four spans of structural steel beams, resting at one end on cast-iron columns, which stand upon the granite blocks from which the arches of the main bridge spring, at the other upon the quay wall, and upon three intermediate walls parallel to the Seine. In these are left seven semicircular openings, shown at the left side of Fig. 19. The passage under the span nearest the river serves for the tow-path, while that nearest the quay wall will permit the passage of two lines of tramways. At the ends of the second span are two flights of steps, by which the public will have access to the quay and to the space under the other two spans. The pylons, placed at the extremity of each balustrade, occupy the width of the third span. At the time of writing, those upon the right bank are very well advanced. The up-stream pylon has reached (see Fig. 11) the height at which the statue and the four columns sustaining sculptures will rest. The pylons on the other end of the bridge are not yet so far advanced.

The metallic part of the bridge is composed of two parts, which will be considered in order—the cast-steel arches and the sheet-steel platform which they support.

On account of the costly nature of cast steel the engineers were obliged, in their design of the arches, to observe the greatest economy of material. To cast steel properly is much more difficult than to cast iron, on account of peculiar conditions encountered in cooling it. That the risk in moulding might be minimised the pieces were made as simple as possible and as much alike as the design permitted, for in this way experience acquired in the successful casting of one would render the manufacture of others more certain and safe.

Normally, the neutral line of a three-hinged arch should approach in general form the curve of pressure, and consequently the material should be distributed around this line with a gradual entasis. Furthermore, in order that the intrados should have the greatest possible rise, without making the roadway too high, the thickness at the key must be kept at a minimum. These conditions were satisfactorily accomplished, with due regard to æsthetic considerations, by diminishing the depth of the arch-members proper from 1.50 metres at the entasis to 1 metre at the springing, and .90 metre at the key. These

data, calculations into the detail of which it is unnecessary to enter, gave definite form to the arches, while at the same time certain exigencies of manufacture have been observed in the dimensions and weight of the voussoirs. The number of the arches was fixed at fifteen, and their distance apart at 2.875 metres, centre to centre. The length of the voussoirs was limited on account of shrinkage in casting. To determine them the chord of each half-arc was divided into sixteen parts—fourteen of equal length, 3.625 metres, and two shorter parts (at the ends)—the corresponding lengths of the voussoirs being from 3.615 to 3.725 metres. Each is cast with flat rectangular ends, which are carefully machined to fit over their whole widths, fitting-strips being left to compensate for any irregularity. Then connections between them are made with twelve bolts.

On account of warping and shrinkage, it was impossible to make any two voussoirs absolutely identical, and it was impracticable to tie neighboring arches together with any system of cross-bracing. The system of support was reduced to simple struts standing on the extrados, but at the middle of the bridge, where the small thickness of structure allowable required the suppression of all intermediate pieces, the superstructure was bolted directly to flanges cast on the upper surface of the voussoirs.

The voussoirs which form the hinges at the end of each half-arch are of quite a different shape from that of the intermediate voussoirs, the ends forming bearings for cylindrical knuckle-pins, while the upper and lower flanges of the arch come together into one mass of metal. At the springing-hinges the thickness of metal of the bearing is 15 centimetres, while at the key it is 12 centimetres, the length of bearing in each case being 80 centimetres.

The pillow-blocks at the springings are of a design harmonising with that of the terminal voussoir, which they resemble in general arrangement. It being impossible that the parts of the arches should be rigorously of the desired size, a shim of a few millimetres thickness is put between each key-voussoir and its neighbor as a means of adjustment.

The method of assembling the arches is of great interest. This operation is one of much delicacy, for the least mistake may compromise the final success of the undertaking. In this case it was more delicate than usual, because the contractor was required by the specifications under which he worked to carry the centerings of the arch upon a movable bridge, capable of being placed in successive positions for the various arches, without interfering with navigation in

the stream below. This gigantic travelling-crane is supported by tracks upon which it rolls in making its transverse movements, these tracks being placed on the abutments. As the absolute necessities of navigation require a passage of only about 50 metres, the ends of the arches, near the springings, were mounted on centerings supported on piles on each side of the central passage. In this way the moving bridge was relieved of a large part of the load of the arches when they were being erected, and while this method of doing the work required most expensive auxiliary apparatus, at the same time it permitted the simultaneous assembling of two arches.

The size of the moving-bridge makes it the most important piece of erection apparatus ever built in France. The distance between the shore supports is about 120 metres (394 feet). In the construction of this large single span the weights, stresses in moving, and wind-stresses had all to be considered. It is composed of two trusses 5.71 metres apart and 7.50 metres high. These are cross-connected by panels consisting of two vertical struts and a horizontal cross-piece between their middles. Brackets on these and on the struts carry two tracks, on which run the trucks used in handling the voussoirs. Above the central horizontal cross-pieces the structure is stiffened by tension members, while below it is left open for the easy manipulation of the voussoirs of the main arches.

The supports of the moving-bridge upon the banks (Fig. 14) are of pyramidal shape, their upper surface consisting of a triple-panel framework, parallel to the direction of the river. Their height is 5.45 metres, the distance between the end rollers of each set 11.50 metres, and the gauge of the rolling-tracks 4 metres. Upon the false-work in the river the bridge is supported on metal columns resting on rows of piles. The length is divided into three spans, 53 metres for the middle one and 33.50 metres for each of the others, by the support of the false-work referred to.

The structure was assembled on the right bank of the river, its parts having been made and mounted temporarily in the shops of the Maison Schneider, at Cruesot, under the supervision of M. Rochebois. The first pieces of the material were delivered in the middle of July, 1898, and by the use of a wooden scaffolding of the proper height were assembled and put in place in several sections. Figure 15 shows, schematically, the successive steps in these operations. To reduce the stresses on the framing during the overhanging period of the second operation, the end of the moving-bridge was furnished with a light nose, 15 metres long. The three launchings (Figs. 15, 16, and

17) took place on August 20 and September 8 and 30, 1898. None required more than half a day's time, and the movement of boats between the Pont de la Concorde and the Pont des Invalides was only stopped during the second maneuver, and then only for two hours. Power for moving the structure was applied through two windlasses acting with two pullies. The roller-carriages had from two to four rollers each, according to the load upon them. Only eighteen men were required to move this enormous mass, which, with its supporting apparatus, weighed 238.5 tons. Both wood and metal parts held up well under the stress, and at the moment of greatest overhang the sag observed was only 16 millimetres over the support on the shore-piling, while the nose engaged with the apparatus for its reception without necessitating the use of jacks to assist it.

The platform on which the men work at assembling the arches is hung from the moving-bridge by a series of rods, furnished with screws for adjusting the height of the platform, and is so arranged that for a single position of the moving-bridge two arches can be erected. The voussoirs are delivered at the foot of the work, where they are picked up by crane-hooks and deposited very nearly in their final position on the centering, the operation being conducted simultaneously from both ends. Each voussoir is brought approximately to its place by the use, under it, of two oak wedges. Then, to obtain the precise curve desired in the support, plates of metal are laid on the scantlings of the centering, and upon these thin steel shims are laid, the voussoirs being lifted for this purpose with ordinary pinch-bars. The members are united by means of bolts placed in the interior of each of them.

When the assemblage of the first two arches was completed (November, 1898), the moving-bridge was rolled into position for the construction of the next two. This operation was very simply conducted by hand-power, the men using capstans to roll the roller-carriages supporting the moving-bridge.

At the end of February, 1899, at the time of the visits made in the interests of this article, four of the arches were in place. Figure 19 shows the state of the work on the bridge at that time, and allows the elegant form of the arches to be clearly seen.

In conclusion, it is of interest to note the cost of this work. The foundations of the two abutments cost nearly 1,600,000 francs. The metal-work and masonry, of which the architectural part was designed by MM. Cassier-Bernard and Cousin, are estimated at about 4,500,000 francs, making the total cost about 6,000,000 francs.

HYDRAULIC TRANSMISSION AND DISTRIBUTION OF POWER.

By E. B. Ellington.

THERE is some danger that the growing popularity of the dynamo may lead to undue depreciation of the value of older systems of power-distribution. From the point of view of universality of application, electricity possesses advantages to which no other method can lay claim, but there is to be noticed a tendency to assume that, as it can be used for nearly all purposes, it is therefore in all cases the best system to adopt.

In time the true economic limits of the application of electricity will no doubt be better understood, and it will be found that the older systems cannot be displaced for many purposes without the sacrifice of economy in production of the power required and of efficiency in its use.

Water was probably the first substance used for power; the waterfall has from the earliest times been utilized for this purpose.

Notwithstanding the advent of steam as a practical source of power in the last century, and the enormous development that has taken place in its use, water-power under favorable conditions continues to be the best and cheapest obtainable, and, with the exception of wind, it is the only one in nature ready-made. If it were suggested as a practicable method of raising water to evaporate it first and condense it at a higher level afterward, I am afraid the sanity of the engineer responsible for the suggestion would be questioned, and yet on the great scale of nature this crude though direct method has given us a perennial supply of power greater beyond measure than that contained in all the coal in the world.

Electricity is on a different footing altogether. There is, so far as we know, at present no perennial natural source of electricity which can be drawn upon. One of the most valuable results of the advent of electricity as a means of power-distribution is the impetus it has given, and will continue to give, to the utilization of the great natural falls of water the world over. It is a fact recognized by everybody, that water is a very suitable and an extremely valuable substance for power-purposes. It is, I think, also a generally accepted fact that dynamos can be run by water-power, and that by

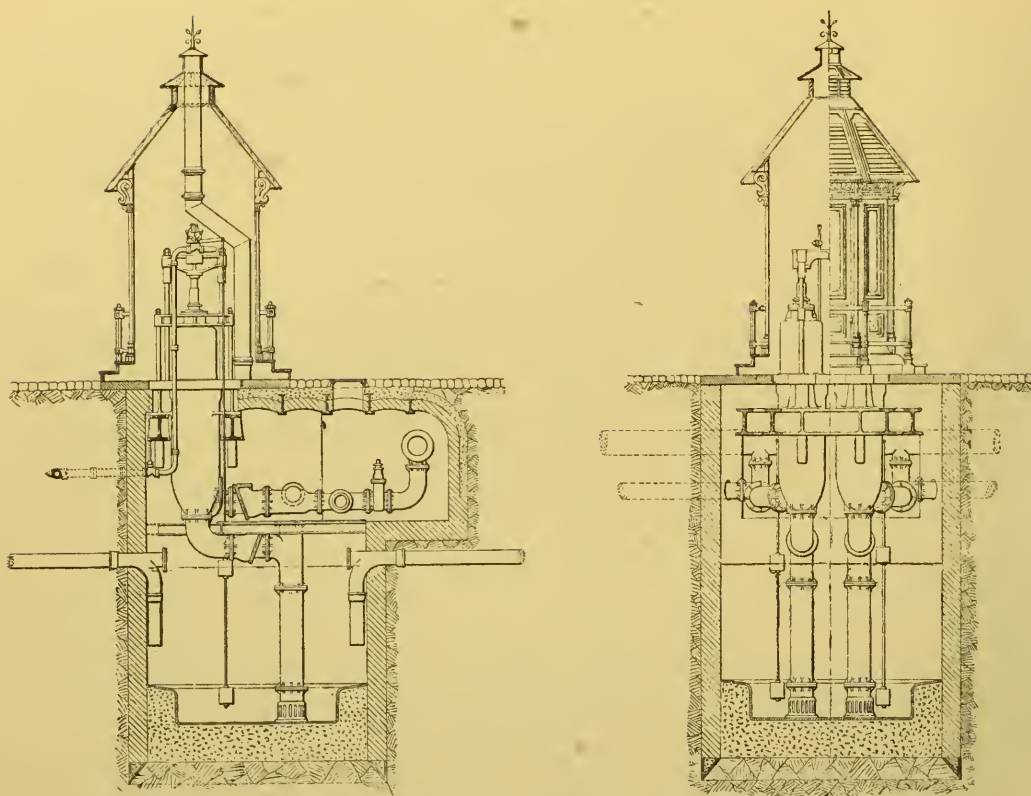


FIG. 1 ARRANGEMENT OF SUMPS AND SEWAGE PUMPS.

such means electrical energy may be obtained more cheaply than by any other method. If this is admitted, then it must be profitable to transmit water some distance to the dynamos, in place of using any other power for production of electricity. There would still remain the question, under what circumstances is it better to convey the water to the dynamo, or the dynamo to the water; and on this point there is a great deal to be said. The loss of power in transmission is in both instances independent of the pressure, and theoretically this loss can be made in both cases as small as is desired.

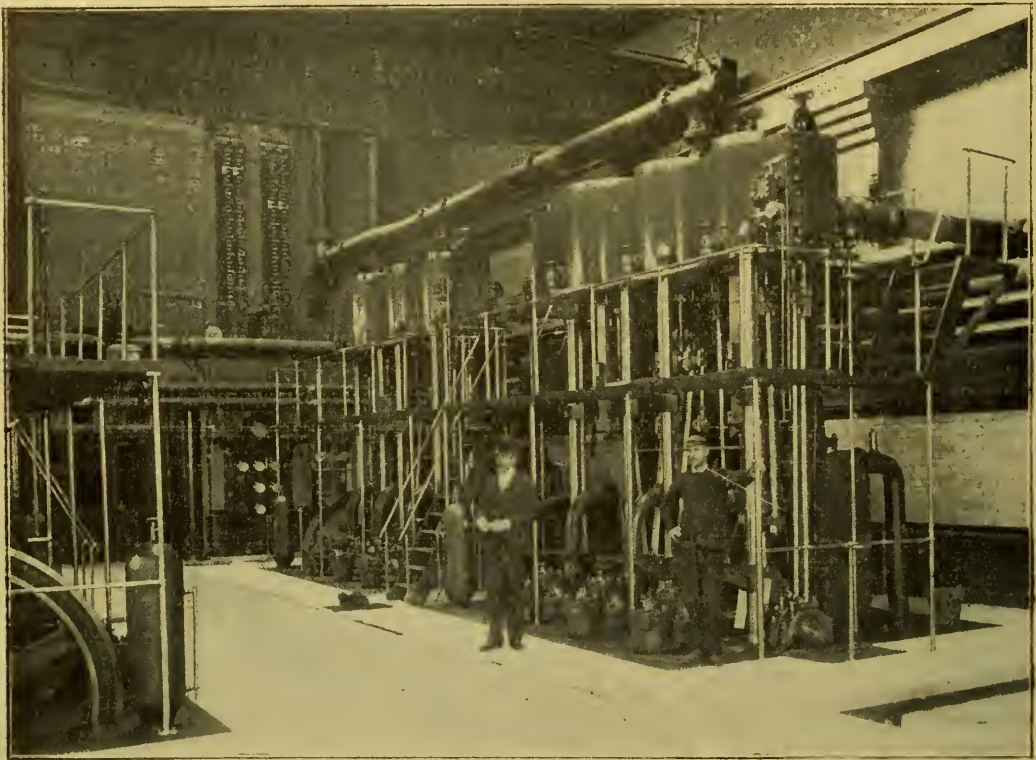
The loss in case of hydraulic supply through mains is inversely as the fifth power of the diameter, while in electrical transmission it is inversely only as the square; but the practical limit of hydraulic pressure is soon reached, while the electric tension can be almost indefinitely increased. It is due to this fact that for long-distance transmission electricity is the only power that can be economically employed. As high-tension currents are unsuitable for most industrial purposes, a second conversion to low tension is required, and as there is a considerable loss in the process, it seems clear that there must be economy in conveying hydraulic power to the dynamo a

certain distance. This interesting question has not received in England the full consideration it deserves, but Continental engineers have investigated the question. One of the first, I believe, to do so was the late Professor Von Rysselberghe, of Ghent, who, in a somewhat characteristic fashion, seemed to think the difference between the fifth power and the square settled the question. He succeeded so far in pressing his views on the municipality of Antwerp that, notwithstanding the hydraulic pressure had to be created artificially at a central station, hydraulic instead of electric transmission was adopted for the electric lighting of the city. The conversion into electric current is effected by turbines and dynamos at several substations as it would be from natural falls of water. The turbines and dynamos are not of the most efficient sort, and the general efficiency of the system is low, but the cost of fuel per unit generated compares not unfavorably with many electric installations. MM. Bergès and Bravet, in a communication to the Société des Ingenieurs Civils de France, in May, 1897, on the project for the electric lighting of Lyons by means of water-power from the Rhone, showed that it would be more economical to carry power hydraulically from the falls to Lyons and effect the conversion there than to use high-tension currents with transformers.



FIG. 2. DOUBLE HYDRANT, WITH HOSE ATTACHED.

The system advocated by these authors involves the conversion of the waterfall into a high-pressure supply, and the subsequent conversion of this high-pressure water into low-tension current. In the ordinary system there would be the initial conversion of water-power to high-tension electric power and the subsequent conversion of high into low tension. It was, no doubt, a wrong conclusion for M. Bergès to arrive at, though theoretically his calculations were correct. The main factor governing these questions of long-distance transmission of power is not, however, theoretical efficiency,



ENGINES OF LONDON HYDRAULIC-POWER COMPANY, WAPPING STATION.

but capital outlay and cost of maintenance; and the position of the turbines and dynamos in relation to the source of the water-power to be utilized must depend on local conditions.

The combination of water-power and electric transmission is apparently destined to become the predominant means of power-distribution. At the present time, however, notwithstanding all that has been done in this direction, the distribution of power as a whole is dependent principally not on any natural supply, but upon fuel. The term "hydraulic power" is generally applied to water-power plants where steam pumps and accumulators are used to create and

maintain a high water-pressure (usually about 700 pounds per square inch) in closed mains. There are cases, especially in California, in connection with hydraulic mining, where a pressure of 600 pounds per square inch and upward is obtained from a natural fall, but with these exceptions, wherever there is a distribution of hydraulic power the initial apparatus is a steam-pump or its equivalent. Of course any waterfall can be made to drive a pump as easily as a dynamo, and the conversion of any low-pressure supply into high-pressure can be effected by means of a differential pump with a loss of about 10 to 20 per cent. in the process. It is rarely advantageous to do so, owing to the cumbrous nature of the apparatus required. The most common case occurs when the flow of the stream is made to actuate a "hydraulic ram" to send a portion of the water to a higher level. There the apparatus is very simple, but the efficiency is low. Low efficiency in such case is seldom of any consequence. The converse case, in which a small quantity of high-pressure or hydraulic-power water is used to raise a large quantity at a less pressure, is frequently resorted to, as in mining and in sewage hydraulic pumps (Fig. 1), and also in injector fire-hydrants (Fig. 2). The efficiency of the former may be as high as 80 to 85 per cent., but is a good deal less if the low-pressure is only a few feet head. The efficiency of the fire-hydrant also varies considerably under different conditions, but is never more than 33 per cent. Like the "hydraulic ram," which may in a certain sense be considered its converse, it is a most useful apparatus, owing to its great simplicity, and it is also interesting as being the nearest hydraulic analogue to an electric transformer. The singular close analogy between hydraulic and electric mechanical phenomena has been frequently pointed out, and here we have a case of hydraulic induction. This, however, by the way. Usually where hydraulic power is required it is necessary to start with a steam-pump. Now, the pumping of water at a comparatively high pressure has long been recognized as giving the best duty of any work that a steam-engine can be set to do. In the celebrated trial of the "Milwaukee" pumping-engine, by Professor Thurston,* the combined mechanical efficiency of the engine and pumps was about 90 per cent.

The efficiency of a steam-engine driving a dynamo may, under the most favorable conditions, press the pumping of water very close, but certainly does not excel it. As in practically all cases of power-supply the engines can not be kept continually running at

*Transactions Am. Soc. Mech. Eng., Vol. XV.

their maximum output, the advantage in practice of pumping water over working a dynamo is very considerable, because at light loads the pumping-engine is much the most economical, owing perhaps mainly to the fact that it is the speed only which is varied with the demand.

By far the largest hydraulic-power supply is in London. There are now 106 miles of mains laid in the public streets, constantly charged to 750 pounds per square inch. The cost for coal (sea-borne, rough, small) per 1,000 gallons sold during the past four years has been as follows :

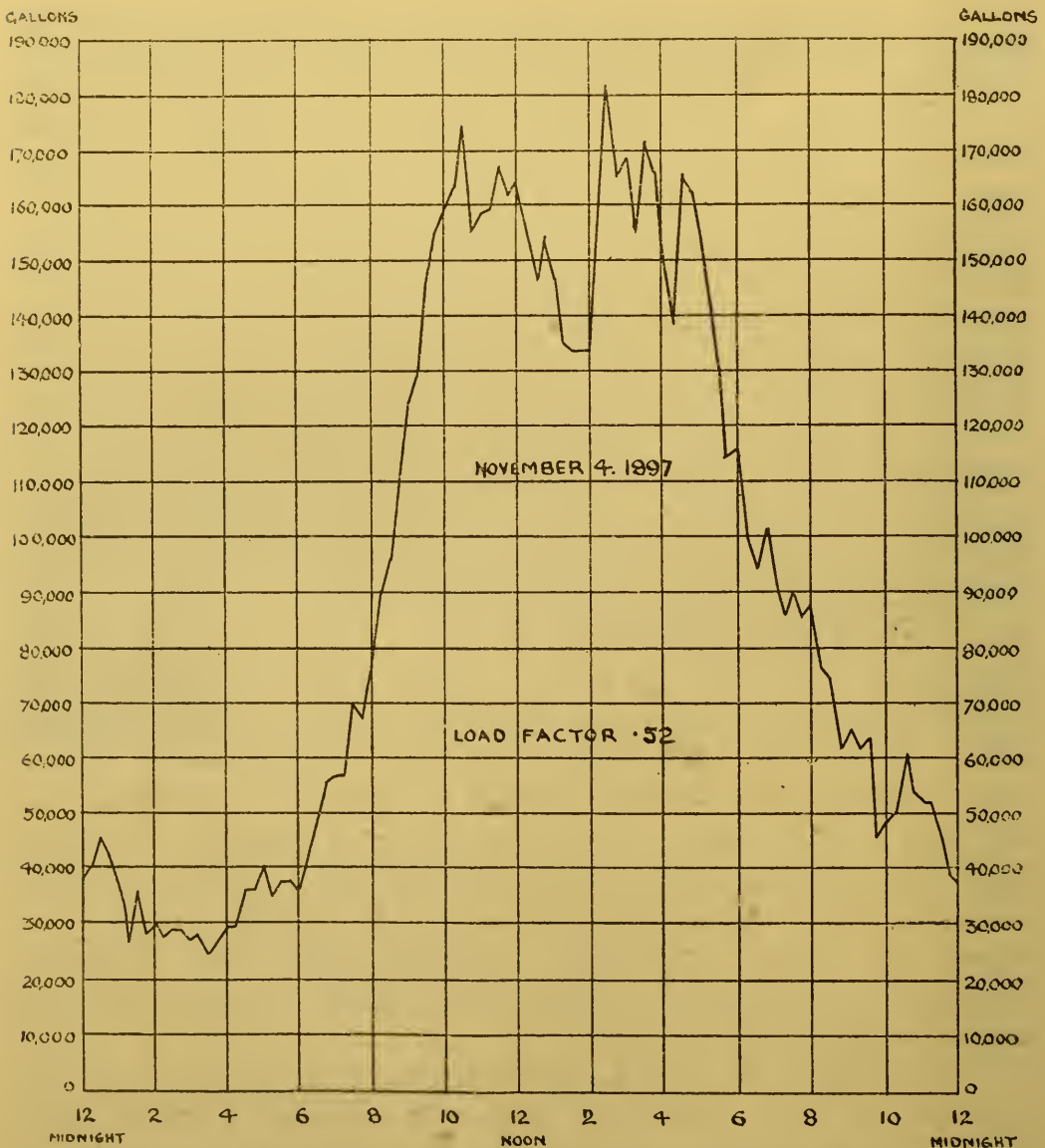


DIAGRAM SHOWING AMOUNTS OF POWER SUPPLIED AT DIFFERENT HOURS OF THE DAY

MAXIMUM DAY'S PUMPING, LONDON HYDRAULIC-POWER COMPANY.

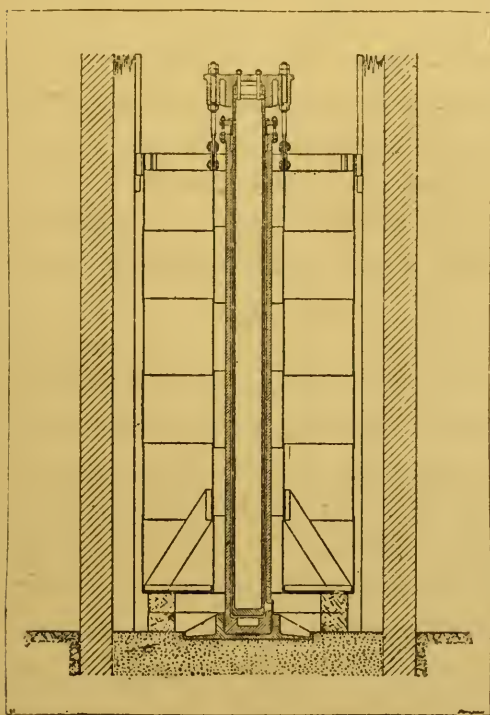
	1894.	1895.	1896.	1897.
Coal-cost per 1,000 gallons sold . .	2.36d.	2.47d.	2.18d.	2.15d.
	1894.	1895.	1896.	1897.
Thousands of gallons sold....	332,390	375,678	412,398	523,732

Everyone acquainted with the subject will admit that this is a very satisfactory statement, but it is by no means the best that the hydraulic-power system can accomplish.

If it were possible to maintain the efficiency of trial-runs of the plant on continuous running at full speed, the cost of fuel would be 40 per cent. less, and if the whole output could be produced at one station instead of at four, at the trial-economy of the best station the cost would be reduced 50 per cent.

The significance of these figures can be made more apparent to those who are accustomed to electrical standards by converting the cost per 1,000 gallons into the corresponding cost per unit.

If the cost per 1,000 gallons is divided by 6.518, it will give the corresponding cost per B. T. unit (kilowatt hour), thus : Cost of coal, London Hydraulic Supply, at per B. T. unit, 1894, .362d. ; 1895, .378d ; 1896, .334d. ; 1897, .330d.



WEIGHT-CASE ACCUMULATOR.
Rim, 20 inches diameter ; stroke, 23
feet 700 lbs. working pressure.

There are four London pumping-stations, situated about three miles apart, provided with engines in all of 4,600 horse-power. Of these stations three are on the river Thames, and one is on the Regent's Canal, City Road Basin. A fifth station, of about 1,500 horse-power, is to be erected adjoining the Surrey docks, Rotherhithe. In all cases coal is delivered by barges alongside the stations. At only one of the stations is the pumping-pressure 750 pounds per square inch. At the others the average pressure is quite 800 pounds per square inch, but, as the difference is necessary in order to obtain 750 pounds throughout, it is, I think, right to make the calculations on the lower pressure. The figures in the same districts of the public

electric supplies in London are very different. The lowest cost in any district in London in 1897 for electricity supply was .51 per unit sold, and the average cost in the principal districts covered by the hydraulic supply was very considerably more.

It may be said that this is not a fair comparison, and that it is necessary to take into account the difference in the load factors between power-supply and lighting-supply. The load factor of the hydraulic supply in London is certainly a high one, the average of the years 1894-97 inclusive being .34, but, as I have frequently remarked, the influence of the load factor alone on the coal consumption of a hydraulic supply is not sufficient to affect the broad conclusion. If the load factor of the hydraulic supply were reduced to two-thirds of its existing value, or about the same as many electric supplies, the coal cost per unit would only be increased about 10 per cent. The load factor has a greater influence in the case of electric distribution, but this is most distinctly a point in favor of the relative economy of hydraulic power. Then there is the question as to how the high load factor of the hydraulic supply in London is obtained. It is often assumed that a load factor of .33, or an average of work of 8 hours in the 24 at the maximum rate, can be depended on in power-supplies, and certainly the experience in London seems to corroborate this view. I have had experience of hydraulic-power supply in many other towns, and in no case except London has the load factor reached so high a figure. London is very peculiarly situated. The same thing occurs with the demand for power, and to a considerable extent for light also. During the day, and up say to between 5 and 6 o'clock in the evening, the principal demand is in the city. It is precisely at this time when the West End demand increases, reaching its maximum about 8 o'clock. Again, there are in a portion of the city and at the East End, the docks, the riverside wharves, and the railway goods yards, where there is frequently a very heavy demand at night. Though the load factor of all these various supplies considered separately varies approximately from .12 to .25, yet their combination produces the high load factors which the hydraulic-power supply in London yields.

No advantage would be gained from this fact if were not that the whole of the districts from Kensington in the west to Limehouse in the east are served from the same stations. Notwithstanding, the highest load factor obtained in any period of twenty-four hours is usually about .50, or twelve hours out of the twenty-four, which is less than is obtained at times by lighting alone in some of the West

End districts. From an examination of the records of the coal consumption of the electrical supplies in London, where the stations are at a considerable distance from the demand, and where high-tension currents and transformers have to be used, it seems to be a sound assumption that it would be impossible to substitute an electric system at the four stations of the Hydraulic Power Undertaking in London and distribute the power over the area covered by the hydraulic mains at the corresponding current and at a suitable voltage for the general industrial purposes of the districts, without a very large increase in the coal-bill over that required for the existing hydraulic supply. The facts given are, I think, sufficient to show that hydraulic power supplied over areas considerable in themselves, yet limited to five or six miles from the source, stands in a quite unrivalled position as regards economy in consumption of fuel.

It is unnecessary to consider in detail other items of the central-station cost. As Professor Kennedy has pointed out, they are substantially functions of the coal-bill.

The accumulators bear an important part in the economy of hydraulic-power supply, but in a large and comprehensive plant, such as that in London, they are not of the same kind of value as in most private installations. Where a bridge has to be opened at intervals accumulators are real reservoirs of power, but in a general supply they are merely regulators of pressure. In London their combined storage capacity only represents about one-half minute's pumping of the whole plant, and at busy times of the day they are usually stationary. Nevertheless they are of great importance in facilitating the control of the plant, so that the constant watching necessary in a large electric central station is not required.

MINERAL RESOURCES OF THE ANTILLES, HAWAII, AND THE PHILIPPINES.

By David T. Day.

THERE are two interesting view-points for studying mineral resources. One is the old idea of hidden treasures, which actuated Columbus in searching for a new world. In a modern view this embraces all minerals which could be exported with profit, if found in any considerable quantity and in reasonable purity. The other concerns all mineral resources which are essential to the development of any comparatively isolated locality; that is, surrounded with even a few hundred miles of ocean, and thus cut off from the economic use of the lower-grade minerals of other lands.

From both view-points the Hawaiian Islands are essentially poor; the Antilles are thoroughly well provided with mineral necessities and advantages; both Cuba and Porto Rico are to some extent supplied with buried treasures; and the Philippines, in the great variety of conditions prevailing in the different islands, can be said to be well supplied with mineral treasures and necessities.

We are already well acquainted with such mineral resources of Cuba as have been or are likely to become valuable exports to the United States. Were it not for the fact that the United States is already better equipped with mineral deposits than any other country in the world, the chances for finding useful application for the minerals of this island would be more favorable. Nevertheless, the cheap water-transportation between Cuba and such ports as Baltimore, Philadelphia, and New York have made us in the past take advantage of the large and cheaply worked deposits of iron ore in the neighborhood of Santiago; and as these deposits are owned in the United States, the use of them will largely increase at Sparrow's Point, Baltimore, and other eastern steel-works. In fact, the condition of the iron-ore trade between Cuba and the United States is epitomized by the picturesque statement, in the *New York Tribune*, that probably some of the shells fired from the fleet at Santiago found their resting place in the very deposits of iron ore from which they were made, because the ore from these deposits has been converted into steel at the Bethlehem Iron Works and at other places, to furnish suitable material for Carpenter and other projectiles.

We will look to Cuba for manganese with much more interest than for iron ore. Even if the exports are not so large, they are more important, because of the real deficiency of supply at present in the United States. These deposits, also in the neighborhood of Santiago, will be developed beyond anything that we could do under the Spanish régime, although the American miner has always been in the habit of mining ores wherever they have been found and under any government, adapting himself most practically to the particular conditions there existing, and in successful competition with the natives.

A great deal of attention will be given to the subject of reopening the old copper mines worked for many years, but closed in 1873, and now flooded with water, and the utilization of them again will be simply a matter of competition with what exists in the United States.

Cuban asphaltum has established itself in the United States market, and the exports will probably continue until they finally succumb to the equal popularity of the various deposits of asphaltum now being developed in the United States. There are so many varieties of asphaltum that almost every use can be supplied from United States deposits. It will be remembered that the conditions of occurrence of asphaltum in Cuba are sufficiently unfavorable almost to offset its ready adaptability for such purposes as japanning and other uses requiring special properties in the crude material, it being thus far found principally under water. Much of it has been used in Cuba for making gas to supply the lack of coal, none of which is found on the island.

Far more interesting than its asphaltum deposits is the suggestion of future value to come from petroleum on this island. So far the production of petroleum has been entirely experimental, but the quality of the oil produced has been most interesting. It is naturally a light-colored oil of agreeable odor, and consists almost entirely of hydro-carbons boiling almost uniformly above 250° and under 300° C. No paraffine is obtained from the oil. The absence of sulphur compounds, which was inferred from the absence of disagreeable odor, was confirmed by boiling with metallic sodium, whereby not the slightest trace of sulphuric reaction could be obtained.

It is reported by Dr. H. N. Stokes that—

“At Santa Clara, Cuba, there is a spring known as Sandalwood Spring, from which issues with the water a certain amount of petroleum, which, from its peculiar odor, is called ‘sandalina,’ or sandalwood oil, although it more closely resembles the odor of cedar. The oil is collected from the surface of the water, and used as illuminating oil and for other purposes without being refined.”

Dr. Stokes found that the oil, which is about as viscous as strong sulphuric acid, is perfectly transparent, amber-colored, and shows the merest trace of bluish-green fluorescence. Its odor, as above mentioned, is agreeable and in no way suggestive of even refined American petroleum, but rather of cedar-wood.

Further search in this direction will undoubtedly be carried forward vigorously, with the object of adding to the already considerable American supplies of petroleum, another producing locality easily accessible, and whose product will be readily transported by tank-steamers to the refineries of the United States, or be directly exported to European countries.

While we are well acquainted with the export minerals from Cuba, we are now interested in the mineral resources of this island from an entirely different point of view—that which may be necessary to promote the successful industrial development of the island itself. The serious lack of mineral fuel on the island can be largely replaced for a long time by the abundance of wood. The sandstone formations of the western end of the island have furnished soils well adapted to the development of large forests of pine trees, while the central portion of the island is also well wooded, and a large rainfall results as the forests are cut down. While the lack of mineral fuel will cause such structural materials as are made of steel to be brought from the United States, although perhaps largely made from the iron ores of the island, other structural materials, such as stone and fictile deposits, are abundant. There are clays for all purposes, and limestone and ordinary marble for the construction of buildings. While the natives of the island have already thoroughly developed the art of using the clays for the manufacture of brick and tiling, there is no doubt that among the limestone deposits plentiful supplies of natural cement-rock will also aid them in their Spanish habit of covering buildings with stucco wherever it is possible. These limestones will be carefully prospected, with the great probability of finding large deposits of phosphate of lime, which will suffice to preserve the fertility of the island and more probably lead to considerable exports.

In short, it can be said that in addition to exporting quite a considerable amount of mineral produce, the island of Cuba could be successfully developed industrially from its own supplies of minerals were it not for the lack of coal, and the extent to which this desideratum will be supplied by petroleum and possibly by natural gas, as well as by the use of wood and charcoal, will be an interesting outcome of the future.

It is perhaps not fair to regard too seriously the obvious discredit of Porto Rico as a producer of minerals, which condition arises from her lack of mineral exports. This means that great mineral treasures will not be easily found on that island, or the work of restless American prospectors for hundreds of years would have revealed them long ago, no matter under what form of government. Geologically, Porto Rico resembles Cuba. We can think of it as a very high mountain, only a small proportion of which (4,000 feet) rises from the deep-sea floor to above the ocean level. Prof. Robert T. Hill, of the Geological Survey, who has just studied its mineral resources, describes it as consisting of three geologic elements: (1) A central system of deeply ribbed and corrugated mountains, with V-shaped gorges and ridges. In this region there are occasional dikes and hard, black, igneous rocks, and in the southern end this substructure is made up of granites, especially syenites. Near Mayaguez some serpentine rocks have been observed. (2) The lower hills around this central group form irregular bands along the north and south coasts. These are exclusively rock of sea origin, consisting of a peculiar type of tropical white limestone; loose-textured, chalky, marly, and shelly, and of different degrees of induration. (3) The third geological element consists of the Playa plains—alluvial soils composed of old reclaimed estuaries, extending from the seashore to the foot of the central mountains, across the line of foothills.

For hundreds of years gold has been washed in small quantities from many of the rivers, especially those of the north and east end. Fifty cents to a dollar a day represents the gain from a hard day's labor. The mother-rock of this metal has not been determined. Much delay in tracing the source of this gold will undoubtedly be due to the effort of the great number of American prospectors in seeking for quartz veins as its origin, of which there is no evidence. It is more probable that the vein-material is pyrite, the general geological conditions resembling those of Colombia and Panama more than the North American gold-fields. Zinc, tin, copper, mercury, manganese, and bismuth have also been reported, but not developed.

Nine tenths of the rocks of the island are of a basic nature, containing a large proportion of iron. Inasmuch as these are and have been undergoing oxidation and alteration, the conditions are theoretically favorable for the occurrence of valuable iron deposits, and in one or two instances Professor Hill states that these undoubtedly exist, notably north of Juncos. At this place there is a large deposit of high-grade magnetic iron ore very low in phosphorus. Its de-

velopment waits upon the construction of a railway. This deposit represents at present the one great claim of the island to mineral resources valuable for export. Further details concerning it will be found in Professor Hill's paper.*

Another likely field for prospecting is the magnetic sand so abundant in many of the stream-beds, notably in the western part of the island. Here many of the heavier minerals, such as platinum, monazite, tin, etc., may be sought.

As regards minerals for the development of the island itself, it is important to notice that coal is not altogether lacking, as in Cuba. Near Moca there is a deposit of lignite well worthy of development. In the western part of the island, near San Sebastian, there is an extensive formation of bituminous clay which contains a fair quality of lignite. Another specimen from the island had every aspect of a good cannel-coal, and it is believed that these fuel resources are worthy of careful study.

The surface of the mountainous portion of the island has been thoroughly decomposed and broken down into clays of all kinds, notably a red clay resembling that of the southern Appalachians. In fact, structural materials of every kind exist upon the island and have been utilized with great skill by the inhabitants. Besides brick and tile clays, excellent lime is produced from the white limestones of coast formation. The blue and gray crystalline limestones of the mountains are also well adapted for lime. Building-stone is plentiful, consisting of volcanic boulders of limestone; of porous, white, massive, quarrying limestone, and limestone flagging. The chief material used, it may appear strange to say, is of the first two classes named. Native masons excel in the art of constructing walls of this lumpy material, binding it solidly together with cement. Near Juana Diaz there is a belt of beautiful marble of great hardness, which is quarried into blocks. It is variegated in color, consisting of a reddish matrix mottled with numerous small white spots. At present it is used only for structural purposes, but it is fit for use as an ornamental stone. Fairly good grindstones are made out of some of the native rocks, although sandstone is comparatively rare on the island.

The salt industry, beds of gypsum, chalk, and silica for artificial cement will undoubtedly give employment to much labor in their utilization; but one of the most necessary latent mineral resources of the island consists of the natural fertilizers, such as gypsiferous and

*"The Mineral Resources of Porto Rico," Twentieth Annual Report of the United States Geological Survey.

green-sand marls in great abundance, and phosphate of lime. These, properly selected, will undoubtedly renew the fertility of many thousands of acres of abandoned tobacco-lands, and probably no more lasting benefit will accrue to the island from American occupation than the application of these neglected native fertilizers to exhausted lands.

The core and mass of the Hawaiian islands consist of volcanic rocks built up from the ocean floor in comparatively recent geologic times; therefore the mineral exports from them are somewhat like those of Porto Rico. The Hawaiian rocks range from basalt to trachyte, forming a complete series, from the most basic to the acidic, but consisting almost wholly of the more basic members. Part are quite fresh and part are much altered by the chemical action of weathering. As the volcanoes, ancient and extinct to the recent and active Kilauea and Mauna Loa, all rise from the deep-sea bottom to, in some cases, great elevations above the sea-level, they are the most notable examples in point of magnitude and interest known. Around the predominating basaltic eruptive rocks is the usual fringe of coral reefs. Some of these have also been elevated far above sea-level, and in disintegrating and then compacting, a calcareous sandstone has been formed, in addition to the coral limestone of the reefs in place. The Hawaiian volcanoes have been enormous laboratories, using the strong decomposing agencies of acid steam, high temperature, great rainfall, and possible sea-infiltration, so that secondary decomposition products are quite numerous. The most important secondary action has been with an acid solution from the volcanoes reacting on easily decomposed limestone, so that Mr. S. B. Dole has noticed among the minerals of the islands sulphur, pyrite, common salt, sal-ammoniac, limonite, quartz, augite, chrysolite, garnet, labradorite, feldspar, gypsum, soda-alum, copperas, glauber salt (sodium sulphate), niter, and calcite. As a rule these minerals have no economic significance, though a few minerals will be of possible value for export, and many will be of importance in local industries on the islands. Sulphur is found in white deposits on the sides and in pockets of the craters and upper slopes of recent volcanic origin. The quantity is so marked in one locality at Kilauea that it is known as the "sulphur banks." As a secondary mineral, pyrite is frequent, but so far not in veins or sufficiently segregated to form a base for acid-making. As a result of the action of the sulphur compounds on the limestone, gypsum occurs in very large deposits, some of it almost pure. The result of this secondary decomposition has been a considerable amount

of mineral paints of many varied hues. The habits of the people do not call for much construction in stone, but there is an abundance of available material of which but little has been utilized. In addition kaolin has been found in pockets of large size and sometimes very pure. Pumice-stone is sufficient in amount probably to justify exportation. Salt is abundant enough for the purposes of the islands. It is likely that the same experience in the pearl industry which will develop in the Philippines, will be extended later to the pearls known to occur in the Hawaiian islands.

At this distance and with the slight exploratory work which has been carried on in the Philippine Islands, the minerals that can be profitably exported are naturally best known. Mr. George F. Becker, in his recent investigation, has given a very clear view of the present mineral exploration in the Philippines, and has shown that gold is found in a great number of localities in the archipelago, from northern Luzon to central Mindanao. In most cases the gold is detrital, and is found either in existing water-courses or in deposits now deserted by the current. It is said that in Mindanao some of the gravels are in an elevated position and adapted to hydraulic mining. There are no data at hand which indicate decisively the value of any of the placers, but the fact that they are washed largely with cocoanut-shells for pans by the natives is an indication of either rich deposits or quite coarse gold. In the province of Abra, at the northern end of Luzon, there are placers, and the river Abra itself yields auriferous gravel. In Lepanto there are gold-quartz veins as well as gravels, and here also is the best-developed sample of copper ores, although these are also reported from a great number of localities on the islands of Luzon, Mindoro, Capul, Masbate, Panay, and Mindanao. This last island is practically unexplored and full of possibilities. The copper region at the northern end of Luzon is unquestionably valuable. Here copper ore had been smelted by the natives, even before Magellan discovered the Philippines. It is smelted in a remarkably complicated way, considering the antiquity of the work. The process consists in alternate partial roasting and reduction to matte, and eventually to black copper. It is generally believed that this method was introduced from China or Japan.

The existence of iron ore in abundance on Luzon, Carabello, Cebú, Pana, and doubtless in other islands, and the fact that a small industry exists in the province of Camarines Norte, on Luzon, where wrought-iron is made into plowshares at a sort of bloomery, brings up the importance of the fuel question aside from the need for a coaling-

station. There is coal in various provinces of the island of Luzon and on other islands. The finest beds thus far discovered appear to be those in the small island of Batan, lying to the east of the southern portion of Luzon. These seams vary from two to fourteen feet in thickness, and analyses show the coal equal to at least a good quality of lignite. Besides these, the coal-fields of southern Luzon and across in the northern portion of Sámar, in Mindoro, where there are large deposits, and Semirara, Masbate, and Panay, all will justify careful exploration, and especially promising are specimens from the southern portion of Leyte, and of remarkably high quality, although nothing definite is known about the deposit. On the island of Cebú are deposits well worth examination. A considerable quantity of coal has been mined there, and the occurrence of petroleum-springs and the reported presence of natural gas make this a likely field for exploration. Seams fifteen feet thick are reported from Uling, ten miles from the capital of Cebú, and such analyses as have been made indicate a fuel-value of about two-thirds of the calorific effect of Cardiff coal, with only about four per cent. ash. On the island of Negros, at Calatrava, there are also coals believed to be important, and coal is known to occur at eight different localities on the island of Mindanao. The presence of lignite is indicated from one end of the coast to the other.

Evidently the supply of fuel in the Philippines is promising, and, taken together with the iron and other metallic resources, would suggest that American metallurgists, instead of supplying this region from the United States by direct exportation, could more profitably export manufacturing plants.

But what is of more interest to the United States, as supplying what may be considered a lack in its own mineral resources, is the possibility of securing supplies of tin ore and of platinum metals from the Philippines, for, while it is probable that the United States may become a large producer of platinum in the near future, there is no question that the usefulness of this material will justify every possible search for it in the Philippines, and, from the geological conditions, with fair prospect of success. It is quite easy to exaggerate the desirability of new sources of tin for the United States. In fact, the attitude of most mineral-writers has been to overrate the desirability of tin mines in the United States. The metal has been given a higher place than it really deserves. It is not generally recognized that the supply of tin for America is neither limited to Cornwall nor dependent upon her mines for any considerable portion of what is used. The fact

PRODUCTS.	CUBA.	PORTO RICO.	HAWAII.	THE PHILIPPINES.
IRON ORE.	Sierra Maestra, a few miles east of Santiago de Cuba, chief metallic product.	Valuable deposits, notably north of Juncos; estimated to contain 10,000,000 tons metallic iron.		On the islands of Luzon, Panay and Cebú.
SILVER.	Mines in Santa Clara yielded in 1837 140 ounces to the ton; now worked on, probably not to be found in paying quantities on the island, and the same can be said with reference to gold.	Washed in small quantities from rivers in the north and east ends, notably the Luquillo and Loiza; also near Corozal.		On Marinduque and Cebú.
GOLD.	Mined at Cobre, north of Santiago, from 1524 to 1867, and occurs in many places in the eastern part of the island.	Frequently met with in the central mountain region, but nowhere in great quantities.		On Luzon, Catanduanes, Mindoro, Samar, Bohol, Libuyan, Panay, Cebú, Mindanao and Panaon.
COPPER.		Found in small quantities near Malapascua.		On Luzon, Mindoro, Masbate, Panay, and Mindanao.
LEAD.		Reported to have been found.		On Luzon, Marinduque and Cebú.
ZINC.				Reported to be found on Panay and Leyte.
QUICKSILVER.				On Mindanao.
TIN.				On Luzon, Mindoro, Carray, Baton, Rapu-Rapu, Masbate, Samar, Semivara, Panay, Leyte, Cebú, Negros and Mindanao.
PLATINUM.				Marble on Luzon and Romblon.
COAL.	Does not exist upon the island.	Deposits near San Sebastian, in the western part of the island, and at Guatemala; lignite.		On Panay, Leyte, and Cebú.
BUILDING STONE.	Limestone abounds everywhere; building sand of Havana is very fine.	Sandstone rare; limestone abounds from Guayama to Cabo Rojo; marble near Juana Diaz; granite near Fajardo.	Abundance of this material, especially limestone and sandstone, but not utilized.	Kaolin mined at Los Baños, in Laguna Province, on Luzon.
PETROLEUM.				
NATURAL GAS.				
CLAY.	For brick and roofing tile in abundance, especially in the eastern provinces.	For brick and potteries in abundance; a few potteries on the island, notably near Ponce.		
CEMENT.	Everywhere in abundance; also plaster.	Chalk, clay and silica for artificial cement abound in the coastal formations.		
MINERAL WATERS.		Several springs, the Quintana at Ponce, and the springs of Coamo.		
PHOSPHATE ROCK.		In abundance everywhere; guano deposits near Ponce.		
SALT.	In abundance along the northern keys.	Rich deposits at Coamo, Guánica, Sierra de Piñones de Cabo Rojo.	An industry of some local importance—sea salt.	
GYPSUM.		In abundance, central mountains north of Juana Diaz.	Very large deposits, some of it almost pure.	
MINERAL PAINTS.			Red and yellow ochre in abundance.	
GRINDSTONES.		Fairly good made out of native rocks.		
ASPHALTUM.	Cardenas Bay; Villa Clara, large deposits, Havana Province.			
PRECIOUS STONES.		Found in central mountain region.		
PYRITE.			Pearls have been found, but not of commercial value.	Important pearl fisheries in the Sulú Archipelago.
FELDSPAR.			Occurs, but not in great quantities.	
MANGANESE ORE.	Rich deposits Sierra Maestra and at Santiago, near Ponupo.		Occurs frequently.	
SULPHUR.			Found around the volcanoes, notably Kilauea.	Abounds around the volcanoes, islands of Luzon and Biliran.
MARLS.		In abundance near Juana Diaz and near Ponce.		

is that the Straits Settlements, together with the islands of Banca and Billiton, yield all that the United States can possibly use, and a desire for tin in the Philippines should be but for the purpose of finding deposits even richer than those in the Straits, and where it would be easier to work them, under American conditions.

Another form of mineral treasure is the pearl-fishing in the Sulú archipelago.

It is evident that the export minerals alone would justify much prospecting in the Philippines. As to the other materials which are likely to develop the islands, much less is known; but it is evident that all varieties of building-stone are plentiful, and that the same conditions which have furnished valuable clays in the Hawaiian Islands and in Cuba and Porto Rico—the decomposition of granitic and other crystalline rocks—have furnished abundant material for constructive purposes in the Philippines.

In general, the report of Mr. Becker has shown fully as great mineral resources in the Philippines as were ever believed to exist. It is evident that the development of these islands will not be hindered by any lack of important mineral deposits.

The table on page 250 summarizes the present evidence of useful minerals in all the islands in question.

THE DEVELOPMENT OF WOOD-WORKING MACHINERY.

By John Richards.

THE operation of wood-planing by means of rotary knives or cutters involves such a diversity of applications that these must be classified in order to treat them in an understandable way. In trade-terms the machines are called timber-planing machines; planing and matching machines; and dimension, surfacing, and moulding machines.

The operations performed by these machines are the most important in wood-working, are also the most expensive, and may be divided, as above, into timber-planing, or squaring up rectangular sections of all kinds without straightening; dimension-machines, in which the timber is moved on carriages, made straight, and planed on one side at a time; planing and matching machines, adapted for preparing tongue-and-groove work, such as flooring, ceiling, and wainscot-boards, and for surfacing one or both sides of boards; surfacing-machines, to thickness and plane one or both sides of boards; moulding-machines, to prepare moulded sections of all kinds, also for grooving, rabbeting, etc.

In all the machines that plane on four sides at a time there is the remarkable difference between American and European devices that they are arranged oppositely in the order of the cutters, or in the course in which the timber is fed through the machines. This feature has been noticed before and will be observable in the illustrations, although at this time there is going on a gradual change of the American machines from the method followed in Europe, which is in substance the same as when material is planed by hand; that is, a "face" is first made on one side, then the edge squared from this face, and, as a final operation, the timber is reduced to an even thickness.

In the American machines, except in some of the later designs, the first operation is to thickness the timber, producing a surface that becomes the "face," but is not the face from which the other sides are planed. The side-cutting is gauged from the bottom or rough side, and a final operation is to cut away a constant amount on the bottom of the piece forming what should have been the face at the

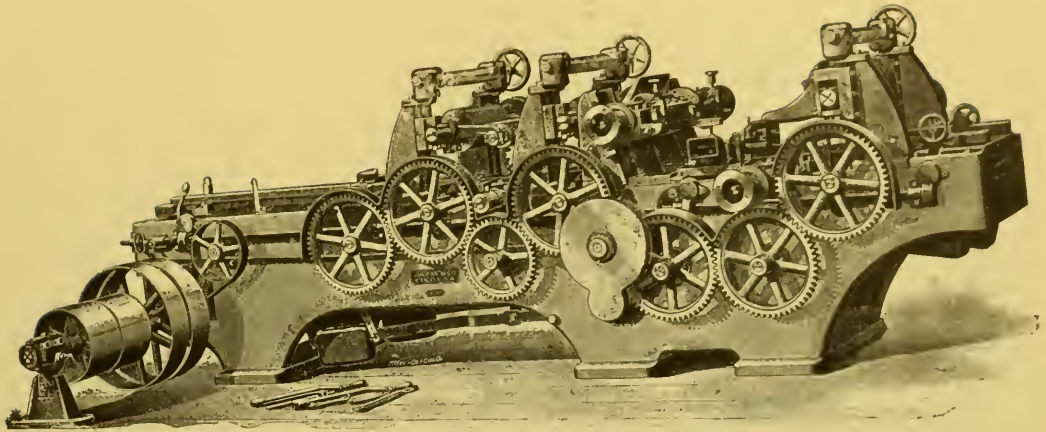


FIG. 1. HIGH-SPEED FLOORING MACHINE.

A typical American machine for producing matched and surfaced flooring in large quantities.

beginning. In this manner tongue-and-groove material is gauged from the back, and variations, or spots unplanned because of the timber being too thin, come on the front or face.

There are a number of objections to this latter-described manner of planing. The faces are not so good and are rougher, because of thicknessing at the same time; the main work is thrown upon the first cutters, and the mass of the shavings is deposited on the machine, interfering with the feeding-rollers, bands, side-heads, and gearing; the timber being dressed on its sides or edges when bearing upon an unplanned surface is unstable and does not bear solidly upon the bed beneath.

How such a difference in the arrangement of planing-machines came about it would be hard to discover at this day. The first

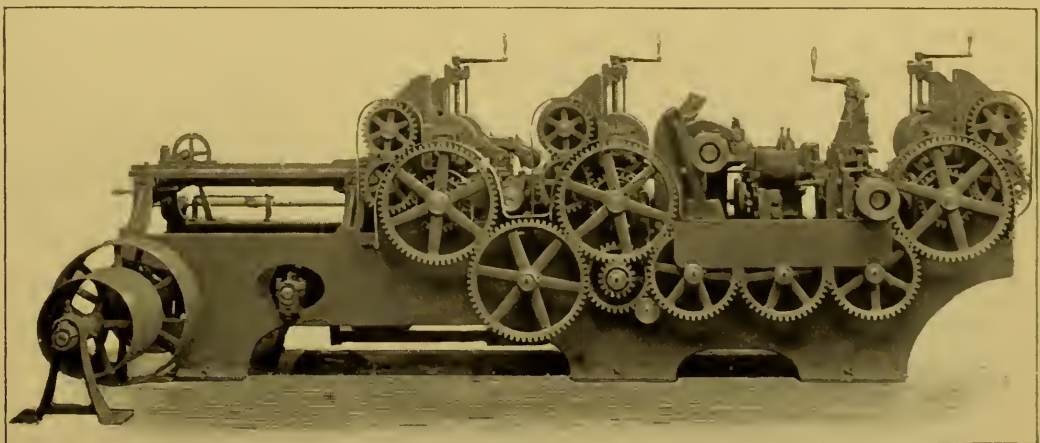


FIG. 2. PLANING AND MATCHING MACHINE.

For flooring and general planing-mill work.

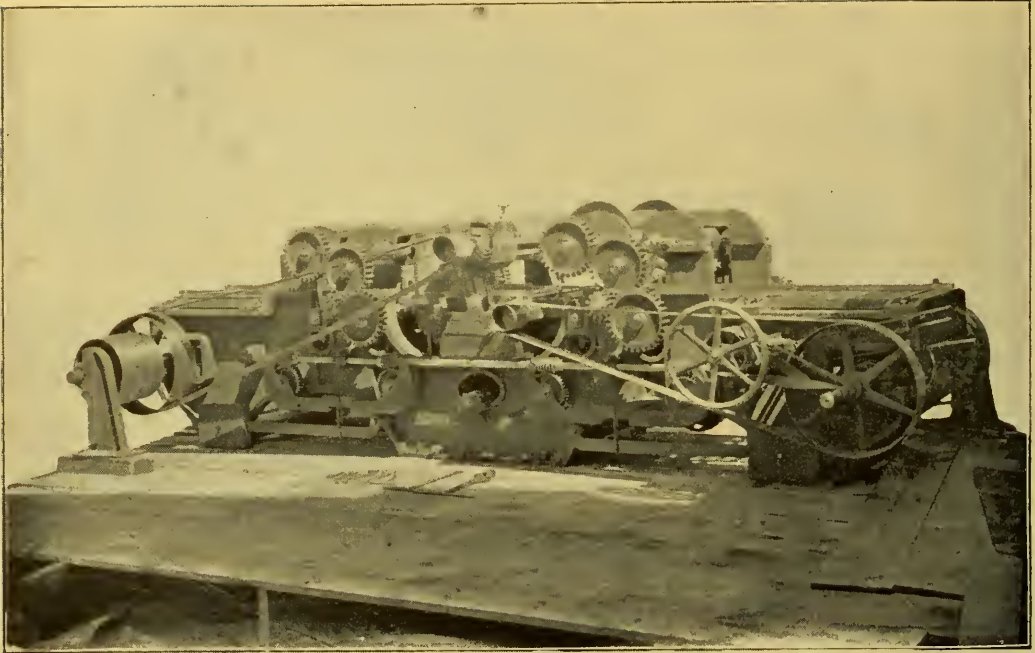


FIG. 3. HEAVY TIMBER PLANING MACHINE, ATLANTIC WORKS, PHILADELPHIA.

For planing four sides at one operation on timbers up to twelve inches square. A powerful and well-designed machine.

machines were made to plane on one side and the edges, and a third cylinder was added to plane the bottom. The theory of operating was not considered. The writer, himself long a designer and maker of such machines, failed to detect this difference between the American and European system of planing until by a misunderstanding he exported a heavy machine to Europe and it had to be returned as unsalable. There is now, as before remarked, a rapid change going on in the United States. Moulding-machines that had always operated the same as planing-machines are now commonly arranged with a facing-cutter to act first on the bottom of the wood, and many planing-machines are made in the same manner. In all other respects, fixed cutters excepted, the details and operative qualities of planing-machines have been thoroughly worked out by American makers, and various features have been extensively copied in other countries.

The advantage of fixed planing-cutters, common in all European machines for plain joiner-work, is the production of smooth surfaces ready for painting and varnishing. There is also the advantage that the rate of planing can be much faster when fixed knives are employed. Twenty years ago a common rate of planing floor-boards in the Swedish and Norwegian mills was 90 linear feet per minute, sometimes exceeding 100 feet per minute, but with machines opera-

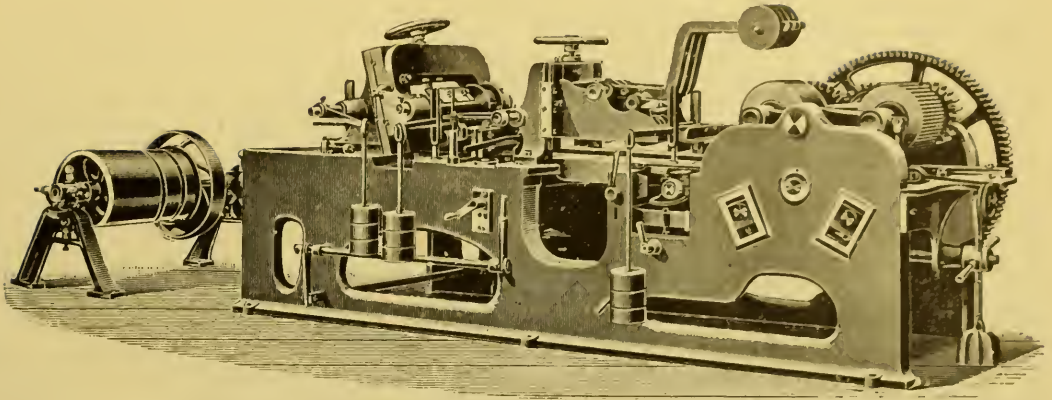


FIG. 4. GENERAL MATCHING AND PLANING MACHINE.

A typical machine of English design, with fixed knives in addition to rotary cutters.

ting with rotary cutters alone the rate of working was much slower than in the United States, because such cutters were driven at a lower rate of speed; besides the wood was more difficult to work.

The market standard for joiners' material is a matter that to a great extent governs the method and rate of planing. In the great cities of Europe—London, Paris, Berlin, and Vienna, for example—mouldings, doors, sash and matched stock of all kinds, has to be smooth in order to be sold, and this causes careful working in the mills and factories of northern Europe.

The subject of working smooth surfaces is one of paramount interest in the United States at this time, and should have the serious consideration of manufacturers of joiners' materials who desire to found an export trade, now to some extent established, in doors.

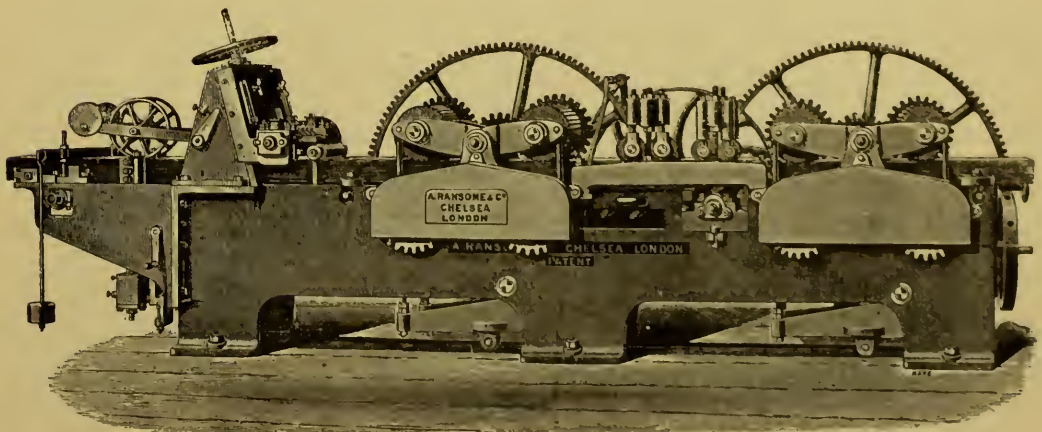


FIG. 5 GENERAL TIMBER PLANING MACHINE.

A good example of English practice, using both rotary cutters and fixed knives.

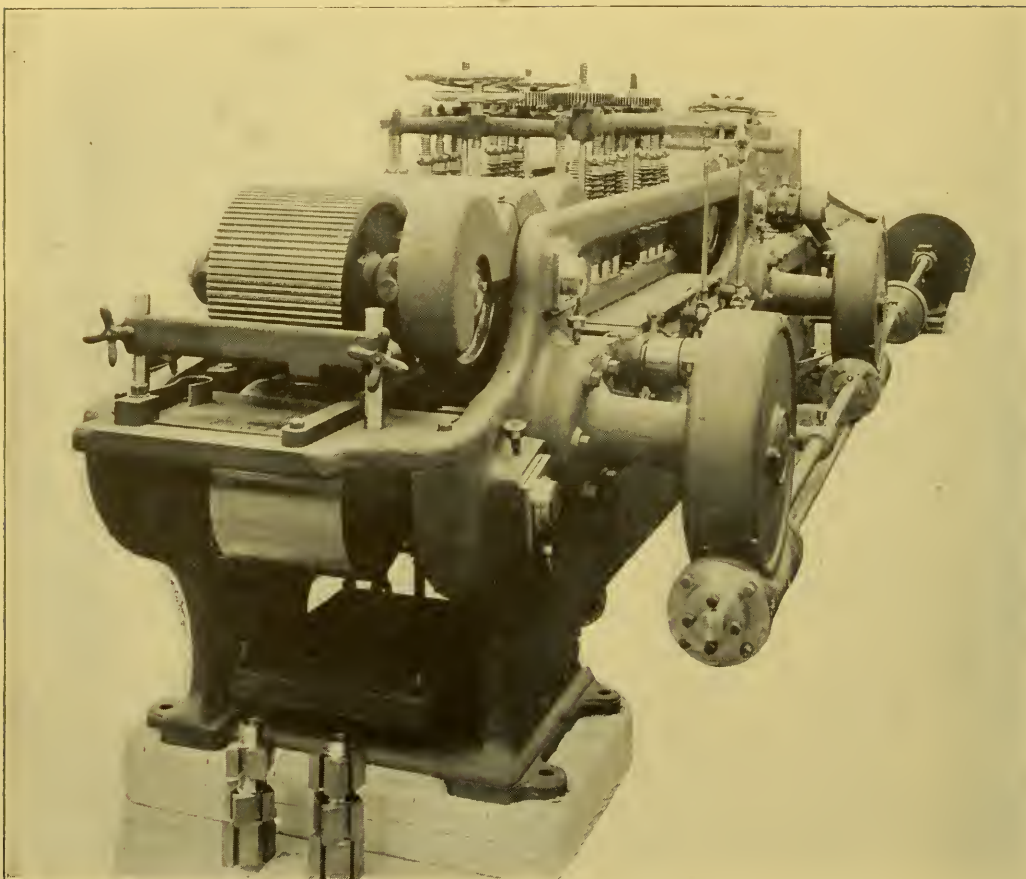


FIG. 6. HEAVY PLANING MACHINE.

Swedish planing machine, showing feeding end.

sashes, blinds, and other things that can be smoothed by sand-polishing machines.

The main articles of export trade should be mouldings, flooring, ceiling and covering boards for painting or other finish, but the present method of planing in America does not produce material that can compete with European mills, such as there are in Sweden and Norway, and as these people have drawn extensively upon American practice in the finishing-class of machines, such as those for mortising, tenoning, irregular moulding, turning, and so on, it would be fair and an easy matter to procure their illustrations of joiner-work for portable buildings, doors, sashes, and the like. Of course there would have to be, to some extent, a new adaptation of machines and processes. A French window, for example, is hinged at the sides, with a weather-proof overlap between the two sashes, which are made much longer than in the United States. The doors are heavier, longer, and differently made. German styles are differ-

ent from these again, but the prices paid for such work are much higher than in America, and warrant the expense of special designs.

Tongue-and-groove flooring is regarded as a cheap expedient and wasteful of timber, also limiting the rate of planing. Export flooring, it will be found, requires straight edges, precisely square, so as to be keyed up solid and made impervious to water or air.

Fixed knives were once attempted in the United States as a means of avoiding the notorious Woodworth patent, on rotary planing-machines, but could not succeed as a sole means of planing. It is essentially a supplementary smoothing process to cut off a thin shaving and remove the marks left by the rotary cutters. There seems to be no difficulty in maintaining these fixed knives. They have, of course, to be kept in good order, but are set in "drawers" that can be pulled out and fresh ones set in without stopping the machines. The illustrations will explain this.

It is remarkable that in America, where fixed knives are seldom used for planing, and not at all in large planing-machines, abrasive smoothing or polishing machines should have had such complete development. Rotary-drum sand-polishing machines are now found in all the principal joiner-works in America, employed for all kinds of parallel-work that has to be "cleaned off."

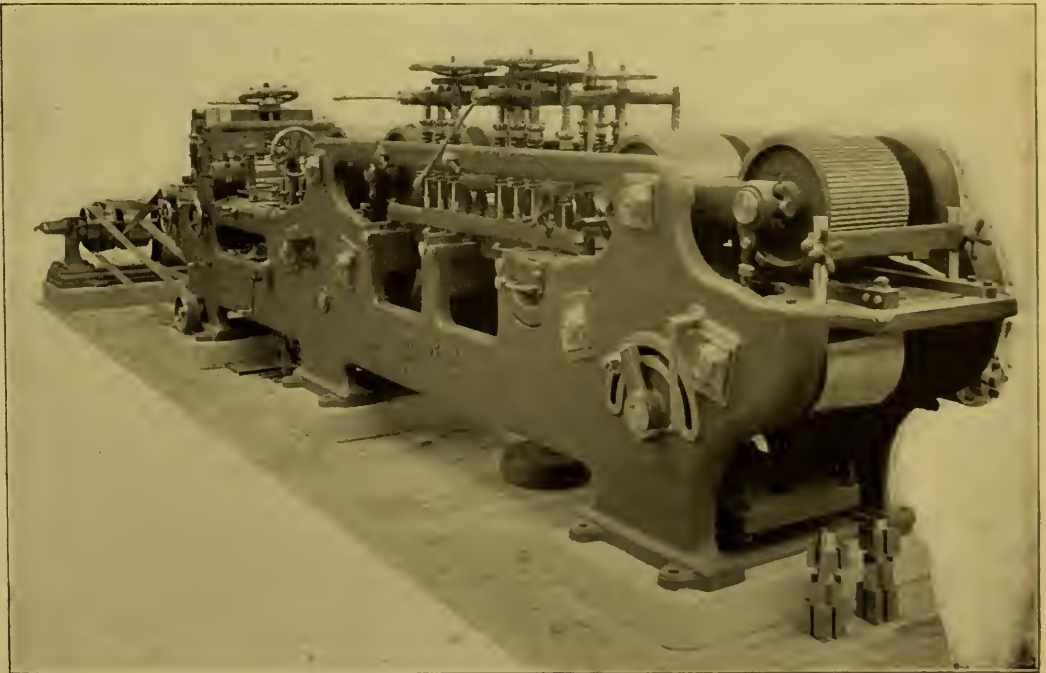


FIG. 7. HEAVY PLANING MACHINE

A fine example of Swedish design, using roller feed, with fixed and rotary cutters.

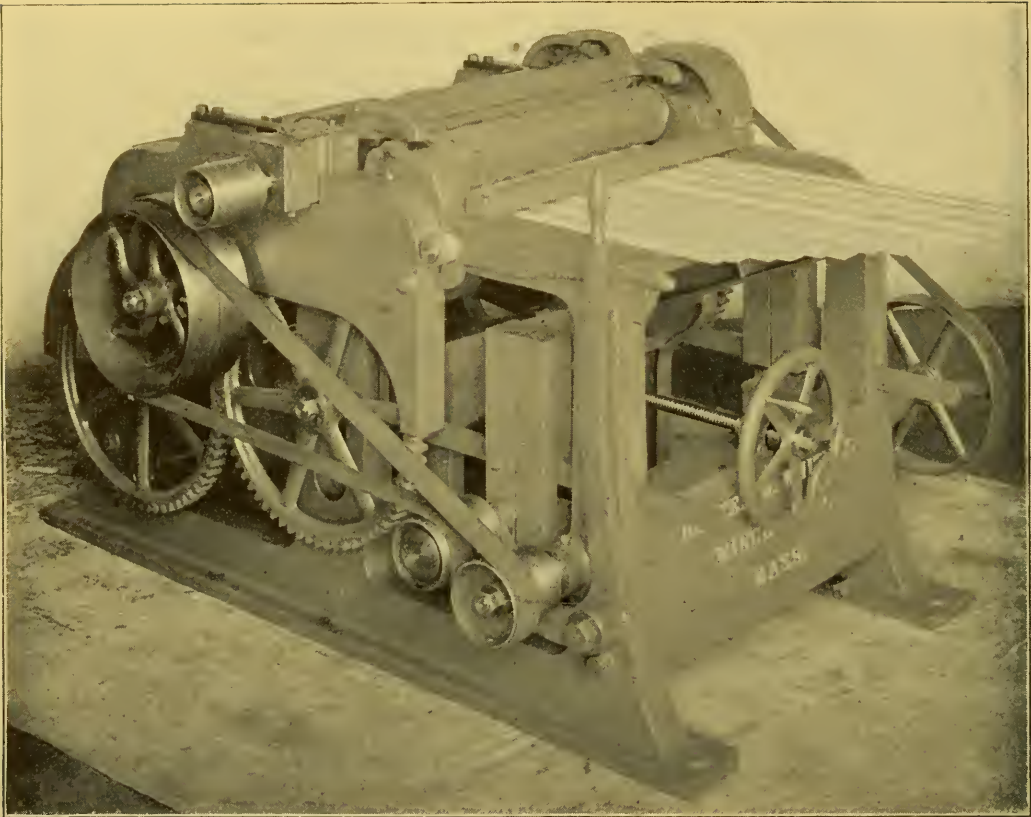


FIG. 8. WHITNEY SURFACING AND THICKNESSING MACHINE.

A remarkably fine machine. The adjustable bed is mounted on inclined planes, giving a very firm support.

There is variation in the practice of making joiner-work, as in all kinds of industry. In some portions of the United States planing is more carefully done, especially where the timber is bad. On the Pacific coast, where material is remarkably fine and clear, the worst planing is done. There is no outside competition to raise the standard of the work. Tongue-and-groove work, such as flooring, ceiling, and wainscoting, is often planed green, with a result that can be imagined, and mouldings are usually planed so rough as to require sandpapering to remove the cutter-marks. Flat surfaces, such as ceilings, have to be replaned by hand if a smooth surface is desired. This is a common result of local competition, which causes a reduction of prices below what will produce first-class work, and prevents investments in machines of the best class. A surfacing-machine that costs \$400 is not likely to do the same work as one worth \$800, and a flooring-machine at \$600 is a very different machine from one costing \$1,200 to \$1,600. They are made with these variations in price, all directed to the same kind of work.

American makers of planing-machines, while they have not attained with rotary cutters the smoothness that fixed knives will produce, have attained with rotary cutters surfaces so smooth that planing-marks are not discernible. It is true that this result can not be produced with cheap or fast-feeding machines, but there are many made that operate in an excellent way, especially those designed to surface both sides so that the second or facing cut is made after the timber is thickened. Provisions to produce smooth working of rotary cutters are: (1) solidity of all parts, to prevent rhythmic vibration—that is, a firm bed, a cutter bar or cylinder of considerable weight and inflexible, with its bearings well fitted; (2) pres-

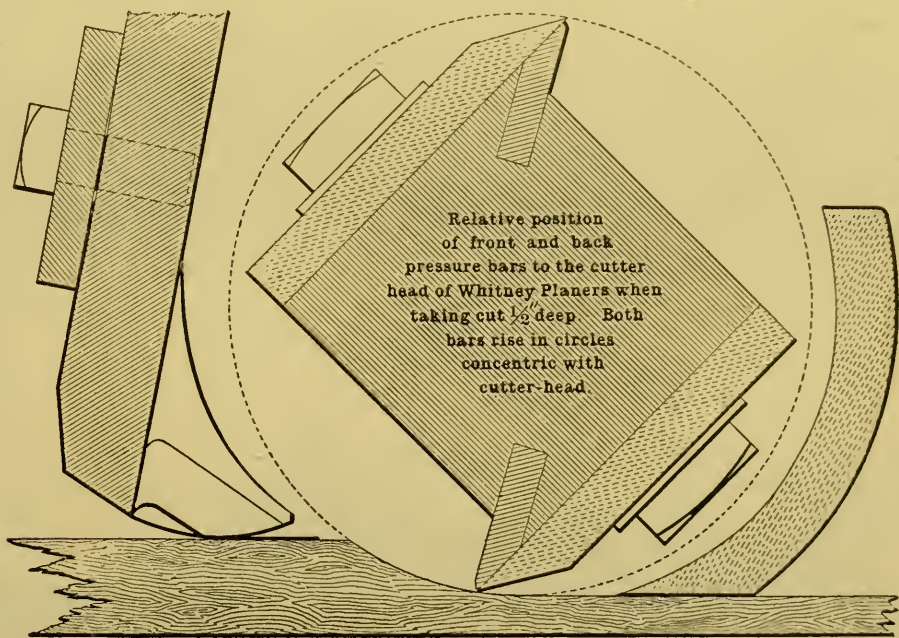


FIG. 9. SECTION OF CUTTER-HEAD AND PRESSURE BARS.

sure-bars that firmly hold the wood close up to the cutters, both in front and behind them; (3) a high speed, to prevent synchronous vibration of any portion of the machine; (4) a movement or feed of the material that permits from twenty to thirty cuts per linear inch.

Fig. 9 is a true section through the cutters, cutter-head, and pressure-bars of the machine shown in Fig. 8, which has produced the smoothest work known to the writer, also the greatest reduction of thickness, as was noticed in the first section of these articles. The maker gives the following description of this device:

The front pressure-bar is made of cast-iron fitted with a flexible spring extending the whole length of its lower edge. Through this spring the weight of the pressure-bar is brought to bear uniformly upon the piece being planed.

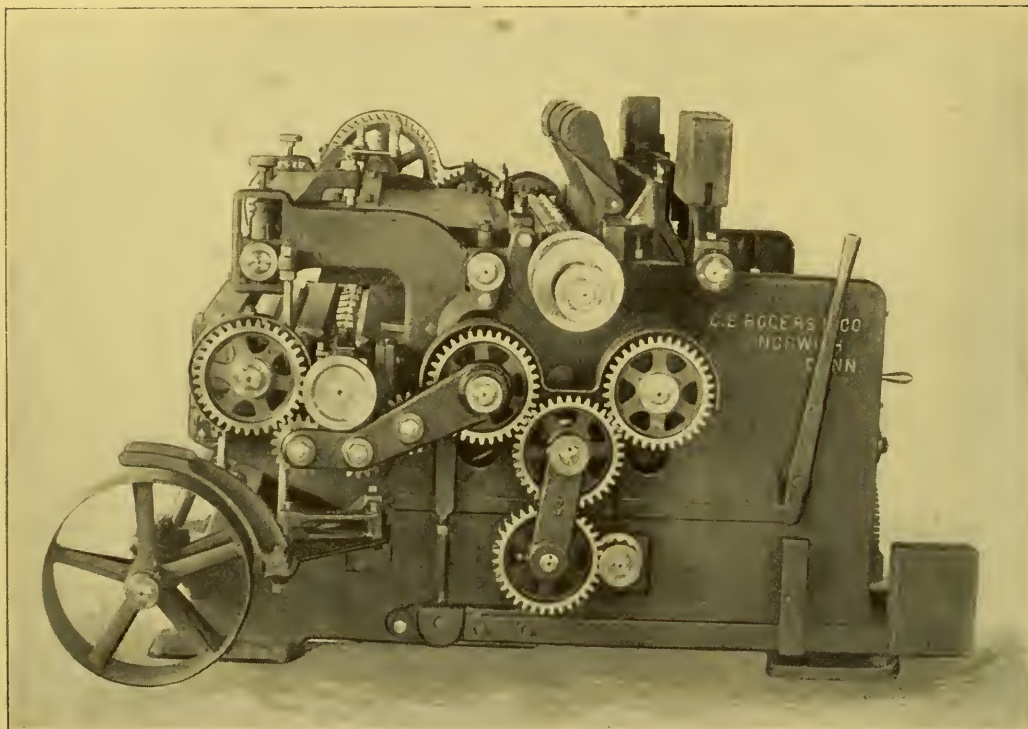


FIG. 10. SURFACING AND THICKNESSING MACHINE.

With under cutter at the rear.

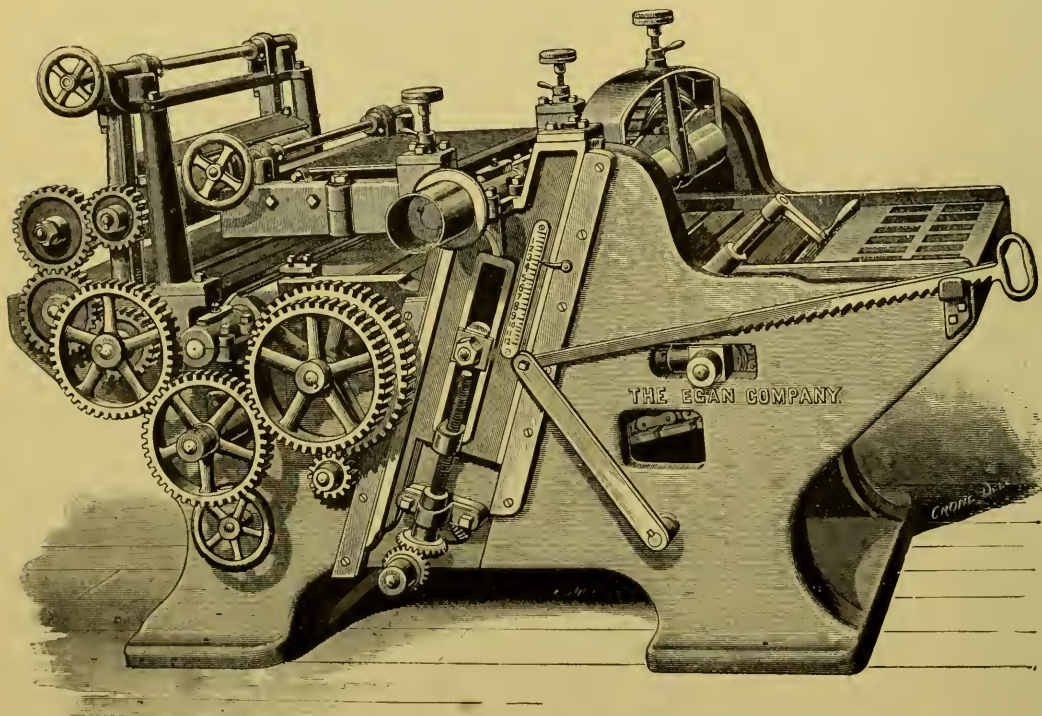


FIG. 11. ENDLESS-BED SURFACING MACHINE.

The wood is fed by the traveling star bed, and a pair of feeding-out rolls deliver the finished work.

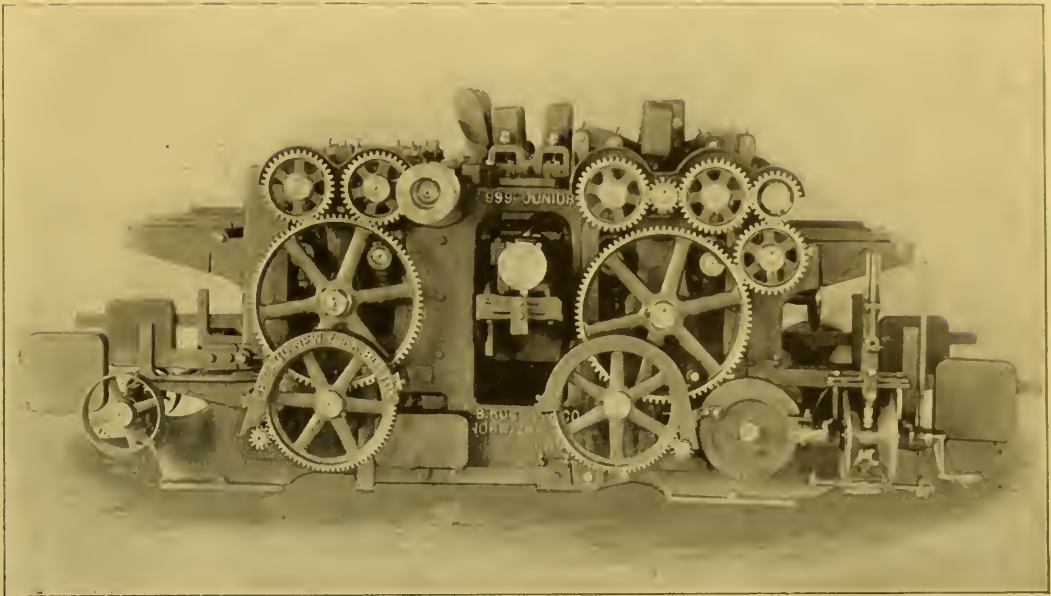


FIG. 12. HEAVY DOUBLE SURFACING MACHINING.

To work both sides, up to 30 inches wide and 12 inches thick.

The edge is flexible, and thus fits into all irregularities of the surface and presses the timber firmly to the bed. When occasionally an unusually large hump or ridge in the stock bends the spring unduly at any point, it curves around the fingers projecting from the back of the pressure-bar until the bar itself rests on the stock, preventing breaking of the spring and interference with the knives. The bar is entirely automatic in its action and presses the wood at a point which is always the same distance from the knives, whether the cut is light or heavy.

The back pressure-bar is made of steel. It is rigid and is pressed upon the stock by springs from above. The flexibility required in the front bar is not necessary here, because the wood has been brought to a uniform thickness before reaching this bar. These two bars acting together hold the wood to the bed at a distance of only $2\frac{1}{4}$ inches apart when light finishing-cuts are being taken.

For hard wood alone the maker would no doubt change the angle of the cutters and set them more obtuse, but as the work of such machines is commonly divided between hard and soft woods, adaptation in this respect must be a compromise.

Besides the typical designs shown in the drawings, machines of this type are made in great variety of form not necessary to illustrate. They consist essentially of one or two cutting-cylinders, feeding-rollers to move the timber, and pressure-bars to hold it down. In some cases the machines are made with endless-chain tables beneath the cutters, dispensing with feeding-rollers. The type is American, and those made in Europe are usually imitations of or adaptations from American designs.

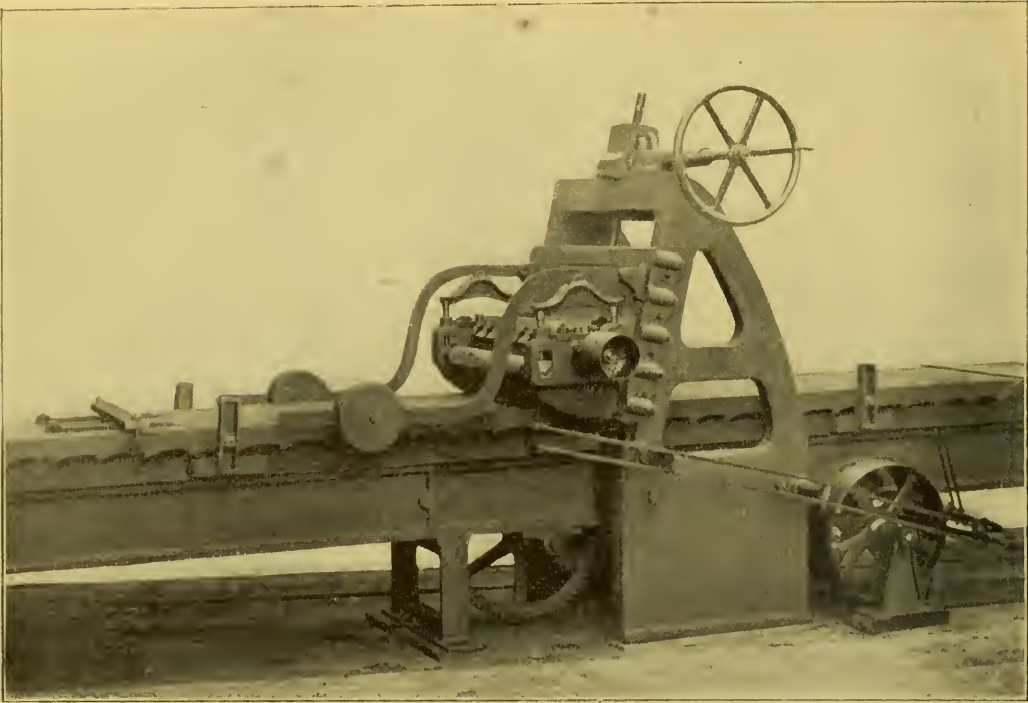


FIG. 13. DIMENSION PLANING MACHINE.

The bed travels back and forth on planed ways.

Carriage Planing Machines are the oldest machines, dating back to 1802 or earlier. Their operation is distinct from that of all the machines that preceded, in that they plane in straight lines, the timber being guided by a carriage and not from its own surfaces. This type of machine, it may also be said, is to plane inflexible timber, while all roller-feeding machines are presumed to plane pieces that are flexible. Of late years the carriage type of machine has been substituted to a great extent by the continuous-feeding kind, because of the faster and cheaper performance of the latter. In fact such substitution has gone far beyond the point that good work demands. In joiner-work as well as in many kinds of frame-work the parts can be forced together by nails or bolts if the section is uniform, but for large pieces it is desirable that they be planed straight.

The carriage planing type of machine is divided into two classes—one in which the axis of the cutters is parallel to the faces to be planed, the cutters being the same as those employed in the continuous-feeding machine; the other class, sometimes called transverse machines, have the axis of the cutting-motion normal to the faces being planed.

It would consume a good deal of space to analyze the difference

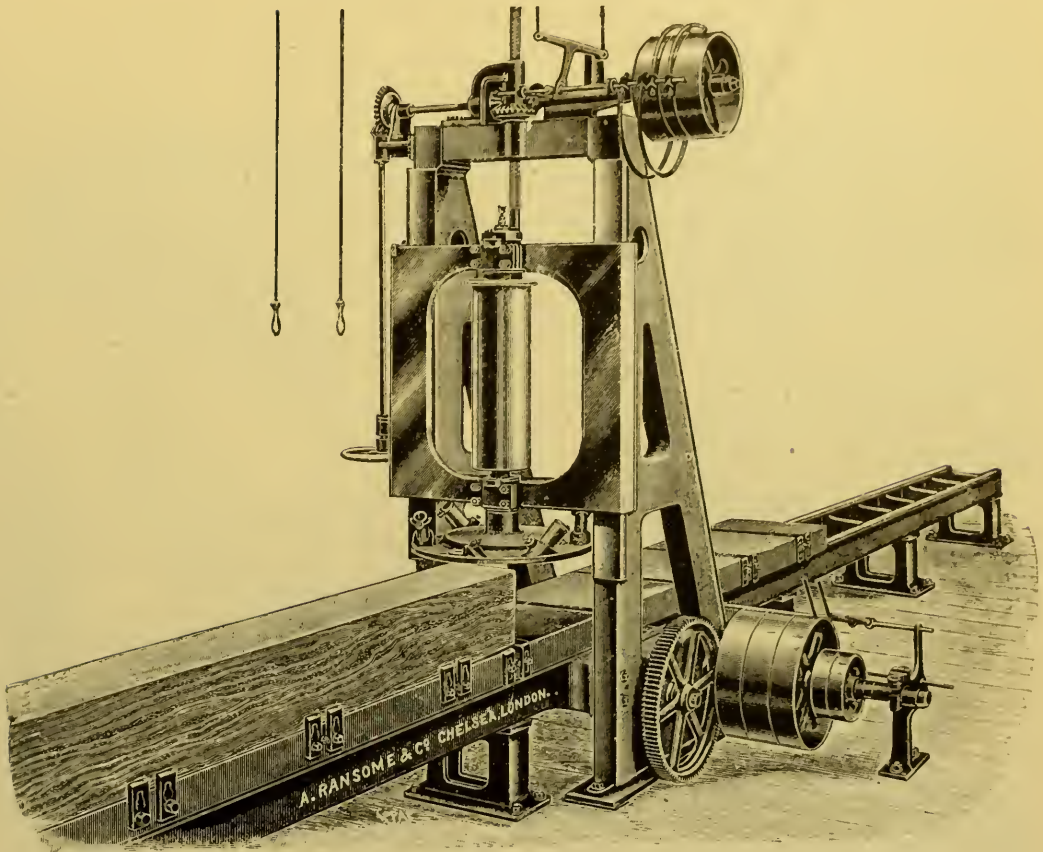


FIG. 14. ENGLISH TRANSVERSE PLANING MACHINE.

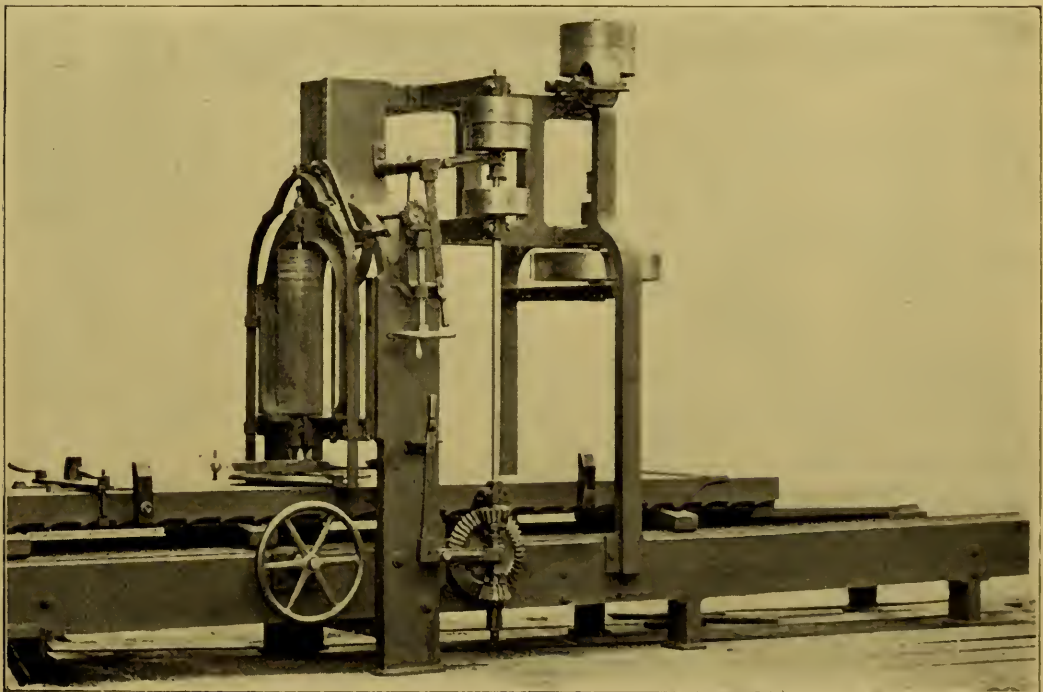


FIG. 15. AMERICAN TRANSVERSE PLANING MACHINE.

between these two methods of planing, and would be without a corresponding advantage. Two transverse machines are shown in illustrations chosen, exhibiting the American and the European practice. The "dimension" machines are American in their origin and were a successful effort to increase the rate at which the traversing-machines could operate, producing smoother surfaces, but less true, because of the timber being exposed to the strain or concussion of the edges acting at the same time across the whole width of the piece. The transverse class operate with narrow edges, not

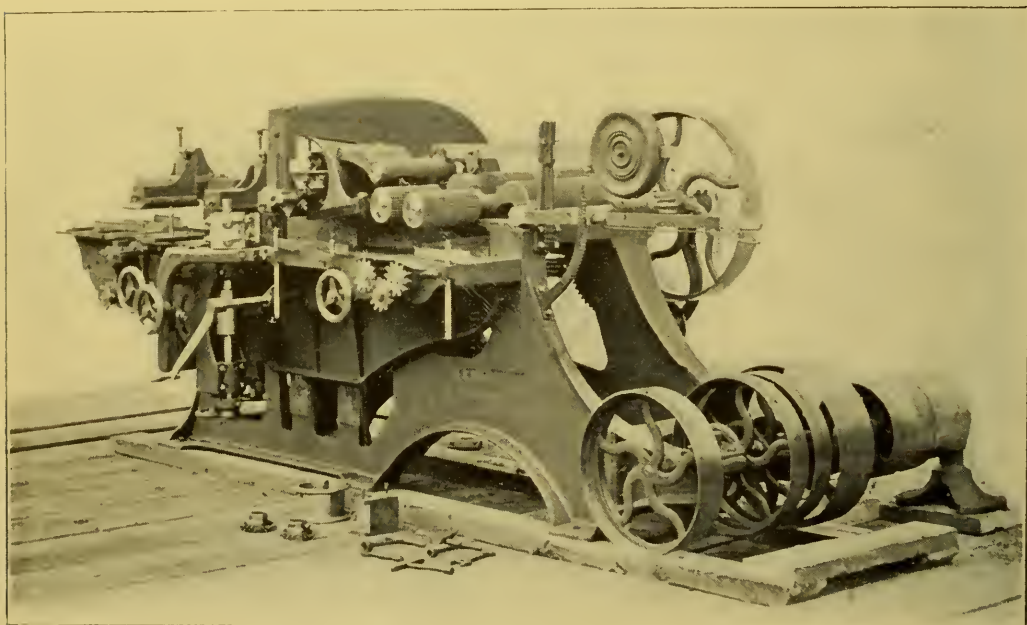


FIG. 16. OVERHUNG MOULDING MACHINE.

Commonly called a "sticker," and adapted for producing a great variety of moulding.

over half an inch wide, across the timber, and cause but little disturbing action, and consequently perform truer work. Machines of this kind are employed in machine-pattern shops, and for work that is to be glued together, also for accurate framing, or for any work that requires to be "taken out of wind" as it is called.

A moulding-machine for wood-working is essentially a small planing-machine for other than rectangular sections. In the United States the line of distinction from planing-machines is more marked, because the majority of American moulding-machines are made with overhung cutter-heads, commonly called outside moulding-machines, and because of the fact that the same machines are seldom employed for two purposes, that is, for moulding and planing. In European practice the two operations are so nearly related, for

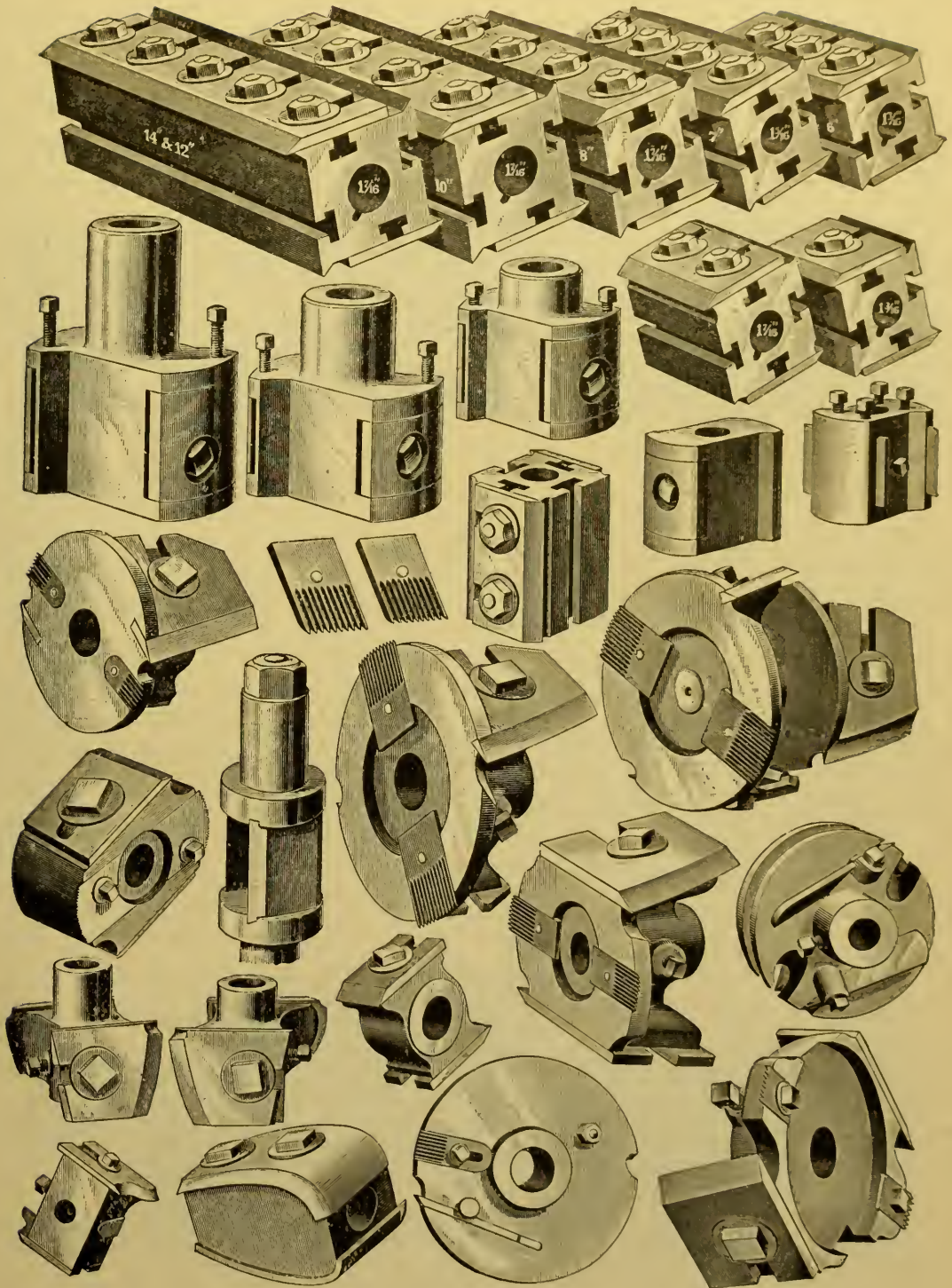


FIG. 17. EXAMPLES OF AMERICAN CUTTER-HEADS

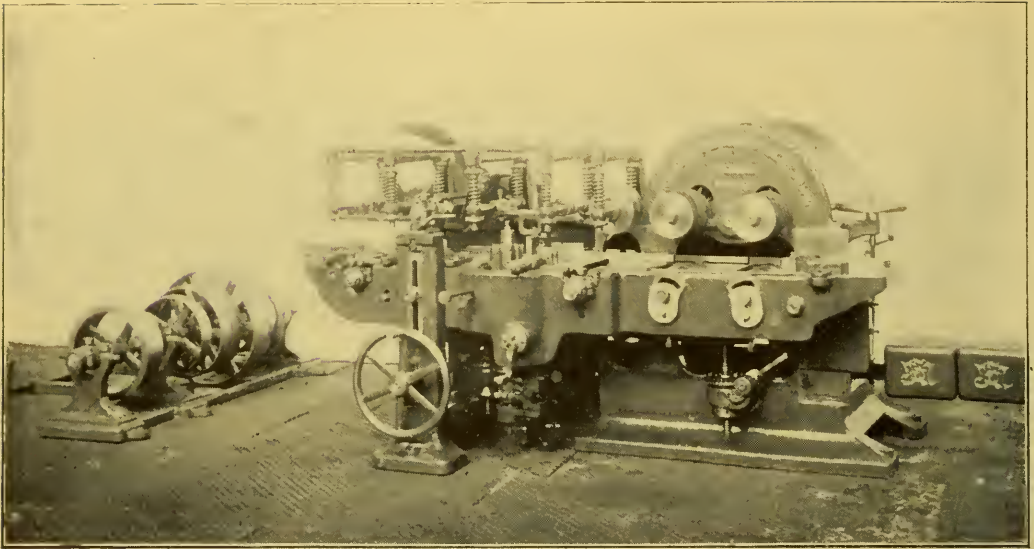


FIG. 18. OVERHUNG MOULDING MACHINE.

A Swedish design, resembling somewhat American practice. Five cutter-heads are used.

reasons that need not be gone into here, that the moulding and planing machines merge into each other without any clear points of distinction. In fact, the same machines are employed for either purpose, or, as we may say, for sections of any kind. The necessary distinctions are in provision for conveniently changing the cutters and in a wider clearance of pressure-bars and other devices to support the timber; also, in most cases, more cutters are required when the figures or sections of mouldings are complicated.

Many of the preceding remarks respecting planing-machines apply alike to moulding-machines, especially as to the order of the cut-

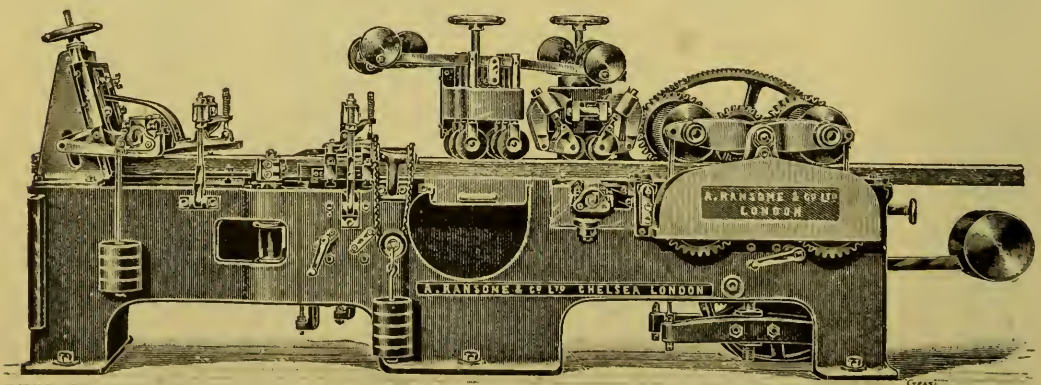


FIG. 19. HEAVY MOULDING MACHINE.

Arranged with revolving moulding cutters above, and fixed smoothing knives below.

ters, which forms a second principal distinction between American and European practice. It has not been possible to find many examples of American moulding-machines among the illustrations where a bottom cutter acted first to form a face, and none where the main top or proper cutters acted last. Notwithstanding this, the writer is aware that a general change is going on in this arrangement of the cutters, and that a facing-cutter acting first on the bottom is becoming common with nearly all the makers.

In European machines, as will be seen by the few illustrations given, the order of the cutter is, first, a bottom one to make a face by which subsequent working is gauged; next, the sides are worked; and then the main top profile is made by the last cutter. In American machines the main profile-cutter acts first, then the side-cutters, and finally a bottom cutter at the rear of the machine. In other words, the arrangement is reversed, or the timber is moved in the opposite direction.

The difference and advantages of these two methods of arrangement has been to a considerable extent discussed previously in connection with planing-machines and need not be gone over again, unless it be to say that if moulding-machines are to become an article of export trade, like many other kinds of wood-working machines, it will be necessary to arrange the cutters oppositely, as indicated, because it seems to be a logical system of operating and one not likely to be changed in future, and is also one that can not be objected to in the United States, especially for that class of machines called "inside" moulding-machines, wherein the cutter-spindles are supported at each end or at each side of the work.

Besides the various types of planing-machines illustrated, there are in common use hand planing or jointing machines that serve a useful purpose. They had their origin as distinct machines in America about twenty years ago, and are in fact a division of what are called universal wood-making machines in the United States, and general joining-machines in England. They are essentially inverted hand planers or jointers, in which a rotary power-driven cutter takes the place of the plane iron or knife.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

V.—THE DEVELOPMENT OF TRADE UNDER COMPETITIVE CONDITIONS.

THERE are peculiar conditions affecting the development, introduction and general adoption of high-grade machine tools in Europe. The most potent factor with which the wide-awake manufacturer has to deal, in introducing new machinery, is the indifferent, non-ambitious workman. He opposes the introduction of improved tools, and rarely suggests a new device, or a labour-saving appliance, by which work can be cheapened or improved in quality. Almost invariably the progressive employer has to force his men to work a new machine. It amounts to this,—that from the great body of workers in Europe few improvements emanate. The workmen demand little or nothing from the machine-tool makers, except the devices their forefathers used; they rarely originate, and they absorb reluctantly. They are, on the whole, a massive, inert stumbling-block to mechanical progress. To say that labour-saving machines, or new methods, can always be introduced, with ease, into American shops would be wrong; but the general spirit among American mechanics is to get the most out of a machine or tool and to improve it, if possible. The tendency among European mechanics is “to make the job hold out,” and there is so little coming from them in the way of suggestion or desire to increase output that their attitude largely influences the policy of European machine-tool makers. I am speaking of conditions, not of causes, many of which work to produce this state of affairs, and not the least of which is the management and supervision under which European mechanics work, by which suggestions and improvements are not encouraged or rewarded, but in many cases actually resented. The conservatism of manufacturers and the pig-headedness of trade unions also have a great influence on the development of machine tools in Europe. The constant effort to save, even the smallest fraction of time, in the handling of work (due as much to the commercial as to the mechanical instinct of American makers of machinery) has been the means of developing the automatic machinery made in America, and now being so largely

adopted throughout the civilized world. The American manufacturer is never satisfied until one man is attending as many machines as possible, or until each machine is turning out its maximum product. He demands more from the machine-tool maker than does the European manufacturer. He expects and receives assistance in the way of improvements, by which he can cheapen his products and improve the quality. Generally speaking, European manufacturers do not keep so closely in touch with makers of labour-saving machinery and improved tools as do American; they are not so well posted as to the latest designs; they stick to this or that maker of lathes or milling machines, and are with difficulty induced to transfer their patronage. They have been well served for the last fifty or sixty years; why disturb the routine of office work by introducing a new name into the books? Old age has its disadvantages. Many European manufacturers are buying obsolete and antiquated machinery for purely sentimental reasons. Business connections between manufacturers and machine-tool makers are still maintained which were established as far back as the time when American manufacturers were buying machinery from England. Such ties are not easily broken. In this light the, to an American, exasperating conservatism of many European manufacturers is easily explained. It would be well if Americans who are seeking a market in Europe for their machinery would try to realize the situation, historically. It has been centuries in developing, and cannot be as rapidly changed as Americans may suppose. The field for American machinery is big; it requires careful cultivation, but the harvest is sure. In the development of automatic machinery the American undoubtedly has, so far as domestic trade is concerned, the advantage of European makers, who are restricted by the conservatism of their customers, dictation from trade unions, and the customs of their forefathers. He also has the advantage of being free to make practical applications of changes suggested by actual experience, regardless of the dogmatism of professors and unpractical technical men, who so largely influence the commercial policy of many European manufacturers. Another condition with which European machine-tool makers have to contend, but is of comparatively little importance in America, is the stagnating influence of government orders. For well-known reasons government workshops are notoriously slow and out of date. The cumbersome, lifeless methods of government transactions are far-reaching, and their influence extends to private workshops which receive enormous orders for war materials. Many English and con-

tinental machine shops are largely affected by government contract work, which cannot be given outside the home country. This state of affairs does not compare favourably with conditions in America, where machine shops are supported under normal competitive conditions, and receive comparatively little patronage from the government. On the one hand, we have the exacting conditions of sharp competition; on the other, the deadening influence of government stipulations. The time must come when manufacturers cannot possibly harbour within their walls engineers and workmen who will have anything but the latest and most highly productive machinery. Such conditions practically exist in America; they are slowly approaching in Europe.

Another important factor which influences the machine-tool business of England, especially, is her immense colonial trade with India, Australia, Canada, and Africa, which have been conquered, settled, and controlled by Englishmen. For years machine tools have been sent to the colonial possessions with little competition from outsiders. The colonial industries are owned and operated by Englishmen, who have little opportunity of becoming acquainted with the latest practice. Consequently they demand the same equipments as they have always been supplied with from the mother country. The producer of machinery at home receives from them few of the suggestions which should come from well-informed and progressive customers. Enormous quantities of English machinery are still being sent to colonial customers, who have little knowledge of the German or American article. France is still largely ordering machinery from England, and American makers well know that there they have made less progress than in any other European country of note. As soon as machinery from other nations begins to be more extensively introduced where heretofore nothing but English has been used, then will the English maker be forced to change his designs, and to offer machinery which must compete with the best the world can produce. Germans and Americans are now sending machinery into English colonial possessions, and, in the end, the effect will be beneficial to England, while her commercial supremacy will surely remain paramount for years, in spite of the repeated statement of well-known Englishmen that their countrymen are liable to be beaten in the commercial race, owing to the better education of the Germans. Having had considerable experience in both England and Germany, I find it difficult to trace this idea to its origin. Like many other popular bugbears, it probably emanates from the politi-

cal platform,—hatched in the brains of those who have had no opportunity for first-hand observation, and simply know that Germany is becoming a lively competitor. I believe it is not true to say that Germans are better educated than Englishmen. They are differently educated,—notably, in the acquirement and use of foreign languages. German manufacturers have the qualification of rapidly adapting themselves to the requirements of customers. At the same time, the German is more rapidly assimilating new ideas than the Englishman. As to real commercial supremacy, however, Germany is in its childhood, compared with England. A large English manufacturer, who is, by the way, a naturalized Englishman of German birth, tells me that he employs many German clerks, but nearly all are under thirty years of age. For the more responsible duties, which come with later years and greater experience, he prefers Englishmen. German education and training produce diligent, painstaking, routine workers and highly-trained specialists, but it seems not to turn out a great number of independent thinkers and practical men,—at least, as far as mechanical affairs are concerned. England has nothing to fear from Germany, if she will but awaken to the fact that her workshops need renovating. In natural resources she is the equal of Germany. In social institutions, which more or less determine the efficiency of workmen, she is the superior. She is not leading Germany, however, in capitalistic enterprise and the adoption of improved machinery. It is to America that England must look for a formidable competitor. There she is outrivaled in every instance but one—foreign trade. In natural resources she is far behind America. In efficiency of workmen she is far behind. She can hope to compete with America in but a few instances. She can compete with Germany easily, if, instead of harping on the superior training and education of the German workmen, she will set about the reform of her workshops and adopt machinery by which she can improve the quality of her manufactured articles and reduce their price.

It is, of course, of interest to American makers who are sending machinery abroad, as well as to the progressive European engineer, to speculate as to the market which exists for good machinery in Europe. Unless a severe general business depression occurs,—which, of course, no one can foresee,—the great quantity of high-grade American machinery which has been sent to Europe, and is still being sent, will appear but a drop in the bucket compared with what should be purchased before European manufacturing establish-

ments can be compared with American. As already stated, it is impossible for an American to understand how so many European manufacturers thrive while still working with old-fashioned machinery, out-of-date methods, and antiquated tools. The use of hand-tools, rough machine work performed on primitive machines, and lack of tool-room appliances, are common, and must be changed; rational methods and new equipments must be adopted. In other words, machinery must be ordered,—lots of it,—for years to come; for the awakening will, in many cases, be slow. With the exceptions, in England, of locomotive works, marine works, and some lines of textile machinery, and, in France and Germany, of military equipment, the workshops of Europe must, generally speaking, be re-equipped from beginning to end, if they would meet American competition. Of course, this cannot be literally accomplished, but the fact of the necessity exists, and it shows what the European market for good machinery means. The chances for American makers to supply a great deal of this equipment are good. They are technically better fitted, with but few exceptions, to deal with customers than is the average European maker. They can advise purchasers as to suitable machines and tools, which are being successfully used in the United States for making articles similar to those that may be in question, by manufacturers who are, as a rule, far in advance of the European manufacturer. Most of the leading makers of machinery in America now have, in a way, the advantage of the European maker, as they know the situation on both sides of the Atlantic. The writer personally knows representatives of more than twenty prominent machine-tool makers who, for some time, have been visiting European countries once or twice a year. The same enterprise is not shown by European machine-tool makers in cultivating the rich territory so near at hand. All leading American makers have agencies established in the more important European countries, which are now as well known as the best local engineers. A majority of American machine-tool specialists, who confine themselves to the manufacture of a limited line, and, in some cases, to one article, are sending from one-third to one-half of their product to Europe. Without doubt, the introduction of so large quantities of American machinery into European markets, during the last three or four years, is somewhat due to the business depression which has affected America for some time, while the engineering business in European countries, during the same period, has been marked by a special activity. The American manufacturer was not slow to

take advantage of the demands in the European markets, in order to offset adverse circumstances existing at home. The American machine-tool maker has been forced to widen his field of enterprise in order to keep his works going, and to dispose of a product not demanded by home consumption. The European market was in a favourable condition; he took advantage of it, and has gained a position abroad which he will never lose. He has made use of American methods of selling machinery, to which the European buyer was not accustomed, but which he has readily accepted. With the certainty of a large market, it is curious that American machine-tool makers, especially the large firms, do not follow the methods of securing business abroad that they so successfully employ at home. I mean the establishment and maintenance of branch houses, managed by engineers who work solely in the interest of their own companies, understand advanced methods of manufacturing, and can make an application of their knowledge to the European situation. If the American wishes to succeed in Europe, he must study his customers by coming directly in contact with them. This is even more a necessity abroad than at home, as the situation in Europe is not yet thoroughly understood by American machine-tool makers, and presents more difficulties than they encounter at home. In America the machine-tool maker is favoured from the side of his customers, who demand highly-developed machinery and the most advanced labour-saving tools. The manufacturer is seeking to reduce the cost of production,—not primarily to buy his machinery as cheaply as possible. With European buyers the reverse is too often the case, and the price of machinery for producing the article is too frequently the most important consideration. Again, the idea of interchangeable manufacture of articles, of every description, is more thoroughly carried out in America than in Europe. The main idea is machine work, and to have the parts made to gauge and finished throughout by machinery. This, of course, favours and encourages the development of, and increases the demand for, labour-saving machinery, as against European conditions, under which articles are finished so largely by hand, with no system of gauging and inspection to secure uniformity in dimensions. There is a good field for the mechanical missionary in Europe.

With unsurpassed natural resources, the most efficient and cheapest labour, and the most highly-developed machinery, it is a pity that the political policy of the United States offers no more encouragement to foreign trade. The government shows no understanding of

the commercial and industrial situation abroad, and manufacturers and workmen are still humbugged by the stay-at-home politician, to whom the sweetest music is the screech of the American eagle, and whose dearest delusion is the necessity of nursing "infant industries." It is curious how American manufacturers allow themselves to be saddled with a policy which so deeply affects their foreign trade, and is not, in any part, tolerated by them in their domestic transactions,—a policy which shuts out competition—the great stimulant to improvement—and the free exchange of goods, which is an absolute necessity to commercial prosperity. In the first place, America has no need whatever for a protective tariff; secondly, she should promote the goodwill of foreign nations by removing all restrictive legislation against the importation of the very few articles in which there is competition. As to 90 per cent. of the manufactured articles used by civilized people, America is beyond the competition of any nation. Why should she seek to put other people on an unequal footing in commercial transactions by imposing a tariff, even on the 10 per cent. in which competition is possible? America is now talking about foreign policy, colonial possessions, and Anglo-American alliance, while all the time saying to others: "Please buy our goods, but we will not take your goods unless you pay us a tax of from 10 to 60 per cent." There is a strong retaliatory feeling in Europe against American machinery (and other goods, for that matter, as well), due solely to the high tariffs imposed upon European articles imported into the United States. Removal of these tariffs would do much to secure the goodwill of a customer whose wants are enormous, and whose wealth is sufficient to supply those wants. Compare the attitude of the United States with that of England, whose political policy goes hand in hand with her commercial interests, and compare the results. In 1895 the total foreign trade of the United States was less than that of Germany and one-half of that of the United Kingdom. The total export trade of the United States for 1890-1894 was, per head of population, less than one-half that of Great Britain, and below that of either France or Germany.*

America is to-day, however, sending more goods to England than France, Germany, and Holland put together, and, as an exporting nation, stands second only to Great Britain. Many interesting deductions are possible from the above facts. Progress in foreign trade has been slow, when it should have been rapid; it has been

*Armitage-Smith, "Free Trade Movement."

made in spite of a protective tariff, not because of it. The most important deduction, however, is that, as far as the machine shop is concerned, America, with her undoubted industrial supremacy, has a large foreign market, in Europe and elsewhere, for machine tools, which is not developed proportionately with her population and resources. It can easily be tripled. It is also evident that her political policy must, in the future, be commercial; not of the narrow domestic sort, that has so far prevailed, but of the broad cosmopolitan nature which is exemplified by England alone. By upholding a protective tariff the American government utterly ignores the first principle of trade—unrestricted exchange of commodities. Instead of protecting herself, she restricts the importation of certain foreign-made goods, which, if sold, add to the purchasing power of other nations which, by reason of unfortunate circumstances are not likely to become competitors as to even 10 per cent. of the ordinary articles of commerce, and never will compete as to those composed of steel and iron. It is difficult to refrain from commenting on the protective policy of France and Germany, which is so largely copied by America. The stupid humbugging of the Agrarian party in Germany is literally swindling the workingman out of his bread and butter. If the free importation of food-stuffs were allowed in Germany, the working power of her mechanics would be materially increased. What is particularly lacking in the German workman's diet is meat. The sustaining qualities of nitrogeous food should take the place of the stimulant, beer, and they probably would, in part, if importation was encouraged. Even with high tariffs and foolish political agitation, Germany cannot shut out the importation of food entirely. There are certain lines in which Germany leads the world, and probably will, on account of natural conditions, but she can never hope to in agricultural products. Her working classes are badly fed, and she should open wide the doors to any nation that would supply food cheaply. If this were done, it would, with the rapid progress she is now making and the enterprise shown by her capitalists, materially assist her as a formidable competitor of England, 70 per cent. of whose exports are manufactured articles and 70 per cent. of whose imports are foods. It should be remarked, in passing, that in no country in the world is bread, the chief article of diet of the workingman, so cheap as in England.

It is of particular interest to the European manufacturer of machinery to note the costs of, and the time taken in, the transportation of machinery, particularly between England and continental coun-

tries, as compared with the same between the United States and Europe. Machinery ordered by cable from America is, as a rule, delivered in English ports in from 10 to 14 days; in German ports, in from 14 to 20 days. Fourteen days are usually consumed in transporting machinery between Berlin and London,—a 24-hour journey. The freight rates between the same points are double those charged for the same goods when transported from New York to London, Liverpool, or Hamburg. This state of affairs is of great disadvantage to European makers of machinery. I know many instances where the time consumed in transportation has alone decided the placing of orders with American makers. It seems impossible to move the cumbersome State railway management of Germany and France to reform in this respect, and, according to all indications, America will remain, for a long time to come, on an equal footing with European countries so far as cost and time of transportation are concerned, in spite of the fact that she is three thousand miles away.

PHYSICAL AND COMMERCIAL ASPECTS OF THE WORLD'S SHIP-CANALS.

By E. L. Corthell.

THE severance of the American isthmus seems assured, and with the completion of an adequate and easily navigable ship-canal from the Atlantic to the Pacific will come changes and expansions in the commerce of the world which can, as yet, scarcely be conjectured. Experience has amply proved that increased facilities create new traffic, greater as the gain in time, safety, or facility becomes more considerable. In a case where the change is so great and far-reaching as that which will be made by the completion of a trans-isthmian water-route, data of existing tonnage carried are of little value as a guide to an estimation of the traffic or the financial profit of the undertaking. Some suggestion, however, may be found by the study of other works of similar character, bearing always in mind that ocean freight-carrying is not much benefited by small savings in time of transit, especially when effected at the cost of more difficult navigation, while the gain from a large saving rises in rapid ratio. No inference can be drawn except by comparison of cases in which the main conditions are generally similar.

With the purpose of giving general data in a department of engineering work which promises to be so active for some time to come, I have prepared this brief review of the history, physical conditions, cost, commercial aspects, and other features of the principal ship-canals of the world.

SUEZ CANAL.

Napoleon I., when First Consul, ordered a survey between the Mediterranean and Red Seas. In 1847 careful levellings were made, establishing the fact of a common level between the seas. The tidal range is about four feet in the Red Sea, and less than one foot at Port Said. In 1852 Count Ferdinand de Lesseps proposed the Suez Canal to Abbas Pacha, Viceroy of Egypt, who did not approve of the project. In 1854 he submitted it to Said Pasha, the new Viceroy, who approved. Political opposition of the British Girt began at this time and continued to near the end of the work, greatly increasing the cost. In 1858 a company was formed, with a capital of \$40,000,000, which began work in 1859. The opposition of Great Britain com-

pelled the Viceroy to withdraw the fellaheen, or native laborers, in number about 25,000. The canal was sufficiently advanced in 1869 to celebrate its formal opening.

The route follows the depression of land extending across the Isthmus of Suez, or nearly the shortest line between the two seas, and runs almost due south. About 60 per cent. of the total length of 100 miles traverses shallow lakes, some of which were dry. The deepest cutting is about midway of the canal, and is 80 feet deep. The original dimensions were: bottom width, 72 feet, $26\frac{1}{4}$ feet deep; side slopes, $2\frac{1}{2}$ and 2 to 1; width at top of these slopes, which stopped about 5 feet below low-water, was about 170 feet; above those slopes were berms with much flatter slopes, so that at the water-level the width was about 250 feet.

The material excavated was principally silt, sand, and some clay, with occasionally thin strata of limestone and gypsum and some sandstone rock. The total amount excavated was about 98,000,000 cubic yards. After the dismissal of the fellaheen, dredgers were built. At the end of 1866 there were 18 small ones and 58 large ones, 20 of which were provided with long shoots to discharge the materials ashore. They were mostly bucket-dredgers, with some hydraulic ones. There were 37 hopper-barges which could go to sea, and 72 smaller ones. About one half the total prism was excavated by the fellaheen and one half by machinery.

At Port Said, to preserve the outlet channel from silting up, and to protect it from waves, a harbor of 540 acres was formed by two breakwaters, respectively 9,800 and 6,233 feet long, converging to an opening of 2,300 feet. Stone being very scarce the breakwaters were built of concrete blocks. The outlet channel must be kept open, partly by dredging, on account of the drift of sand along the coast. At Suez the outlet is well protected in a land-locked bay of the Red Sea. It is, however, guided into deep water by an earthwork embankment on one side 2,900 feet long.

The increasing size, and particularly the increasing draft, of steamships has made enlargements necessary.

Up to 1897 the depth had been carried throughout the entire length to 28 feet below mean level of high tides, with a bottom width of 123 feet. There are no curves of less than 6,240 feet radius. There are sidings for vessels meeting each other, spaced about every five miles; they are 3,280 feet long, but the enlarged width makes of the whole canal one continuous siding where vessels can pass each other at all points. To accommodate vessels of great width, two special

sidings have been made. The depth of water at Port Said harbor is $29\frac{1}{2}$ feet. The longer breakwater has been extended, and is now over 10,000 feet in length. Up to 1889 the maximum draft allowed was 24 feet 7 inches; in 1890, 25 feet 7 inches.

The maximum dimensions of the canal, according to the plan of the International Commission, are to be $29\frac{1}{2}$ feet depth throughout—214 to 272 feet bottom width, with 340 to 462 feet at water-level.

The total amount dredged in 1897 was, in the canal, 921,417 cubic meters, and in Port Said 593,377 cubic meters; in the enlargement, 690,694 cubic meters.

The canal is lighted electrically, either by lights on posts or on the bows of vessels, and it is traversed by night as well as by day. Its original cost was about \$99,000,000, up to the end of 1878, of which \$7,000,000 was expended in the previous nine years, the canal not having been fully completed at the time of opening in 1869. The total estimated cost of enlargement now under way and as above described is about \$40,000,000.

The average duration of transit in 1883 was $48\frac{1}{2}$ hours; in 1887, 34 hours; 1888, $30\frac{3}{4}$ hours; 1889, $26\frac{3}{4}$ hours; 1894, 19 hours 18 minutes; 1897, 15 hours 36 minutes.

The traffic-tables give the following information:

Net tonnage in 1870, 436,609; 1880, 3,057,421; 1890, 6,890,094; 1897, 7,899,373. Receipts in francs, respectively, 4,345,755.42, 36,492,620.25, 65,427,239.22, 70,918,410.43. The general increase by periods is: 1870-80, a progression of 1 to 6; 1870-90, 1 to $14\frac{3}{4}$; 1870-97, 1 to $16\frac{3}{4}$. Number of passengers: 1870, 26,758; 1880, 101,551; 1890, 161,253; 1897, 191,215. The military and naval conditions of the world largely modify this passenger movement. Passenger-receipts, in francs: 1870, 263,552; 1880, 1,015,517; 1890, 1,613,538; 1897, 1,912,150. The rates are, per ton of vessel, 9 francs; per passenger, 10 francs. The total receipts from all sources in 1897 were 75,607,029.40 francs; the total number of ships passing through, 2,986. The total expenses, including interest, etc., were 24,082,204.24 francs.

The capital of the company is 200,000,000 francs, divided into 400,000 shares of 500 francs each. The annual interest on these shares is 5 per cent. The dividends per share, after paying all interests and setting aside the required amounts for a sinking fund, amounted to 97.62 francs in 1897. From the receipts of the first half of 1898, the dividend for that year will be 100 francs, or 20 per cent.

While the periodic increase of traffic is quite regular, in the last

few years, since 1891, which was the year of largest traffic, the canal has felt the industrial, commercial, and financial depression of the world, and certain other causes have conspired to reduce the traffic, particularly during 1897. Indian wheat to England fell off from 447,000 tons in 1895 to 107,000 tons in 1896, and to 29,000 tons in 1897. There was also a loss in rice transportation, and coal to India from English ports fell off from 1,297,000 tons in 1895 to 590,000 tons in 1897. Generally the maritime movement between European ports and India fell off from 4,482,000 tons in 1895 to 3,687,800 tons in 1897.

The tide of a more general prosperity, which began about the first of the present year, makes itself felt in the movement through this canal, the receipts of which from January 1 to May 24 show an increase over the same period of 1897 of 4,860,000 francs.

NORTH SEA OR AMSTERDAM CANAL.

The first proposition to cut through the narrow strip of land separating the Zuyder Zee from the North Sea was made in 1629.

Increasing maritime business required execution of the work to obtain a short deep-water access for the important city of Amsterdam. Several projects were brought forward between 1852 and 1863. In the latter year a concession was granted, and in 1865 the Amsterdam Ship-Canal Company proceeded to build the canal. Hitherto the North Holland Canal, 50 miles long, circuitous and inadequate, had been the only means of access from the sea. The new, larger, and practically straight canal is only 16 miles long. The strip of high land cut through is $3\frac{3}{4}$ miles in width. The original section was: bottom width, 88.73 feet; depth, 23 feet; slopes, 2 to 1, with a small berm at water-level through the sand-hills and a much wider berm below water-level in the lakes traversed. The width in the former case at water-level was 176 feet; in the latter case, 360 feet. The maximum depth of cutting was 25 feet, the sides near the water-level being protected by hills with planking and bricks behind. The canal is crossed by one road swing-bridge and two railway swing-bridges. The work was finished in 1876.

It was necessary to shut off the Zuyder Zee from the canal by an embankment 4,462 feet long, in which were placed locks for that traffic. There are three locks, the largest being 315 feet long and 59 feet wide. It was also necessary to install a powerful pumping-plant at this embankment, to pump the drainage-water out of the canal, sometimes requiring 5,000,000 to 6,000,000 cubic yards in twenty-four hours.

At the North Sea end, at Yunidon, two tidal locks had to be built; they were 393 x 59 feet and 229 x 39½ feet, with 23½ feet over the sill of the larger one and 14 feet over that of the smaller one.

Increase in size of ships recently required a much larger lock to be built, which was completed in 1895. It is 740 feet long, 82 feet wide, and 30 1-3 feet deep over the sills. It was also necessary to build very expensive and difficult harbor-works to protect the entrance to the canal on this sandy and stormy coast. There are two converging jetties, each about one mile in length, built of concrete blocks placed upon a foundation of basalt rock and capped with concrete in mass. There was also placed outside, as a wave-breaker, a line of concrete blocks. The breakwaters are 3,940 feet apart at the shore, and converge to leave an opening of 853 feet between the pier-heads. The available width for navigation is 656 feet. The area enclosed is 247 acres, through which a channel was dredged to deep water, the bottom width of which was 490 and 28½ feet deep. Maintenance of this channel inside and outside the entrance requires the removal of about 650,000 cubic yards per annum, which is done with sand-pump dredgers.

Soon after the completion of the work, it was seen that the depth which was considered sufficient in 1865 was quite insufficient for the larger ships that the times were bringing out, and the depth was increased between 1877 and 1883 from 23 feet to 25¼ feet, with a greater bottom width.

In 1889 another enlargement was begun, which is now nearly finished. The final(?) enlargement will have generally the dimensions of 29½ feet depth; bottom width, 82 feet; with sidings for passing vessels. The still greater section is, however, even now proposed by the commercial interests of Amsterdam, namely, 32.103 feet deep, and 164 feet wide at the bottom.

The canal was ceded to the state in 1882, the expenses up to that date being \$24,770,000. The original work cost about \$15,000,000 and the removal of 21,000,000 cubic yards of earth. Traffic has steadily increased from the beginning, it being five times as great in 1892 as in 1877. In 1892 it was about 3,600,000; in 1897 it was about 5,000,000.

There are no tolls upon the canal, it being owned by the state.

CORINTH CANAL.

The project for a canal at Corinth dates back to the year 600 B. C. Three hundred years afterward the Athenians hauled their triremes, of 150 tons, over this isthmus on a stone ship-railway.

In the reign of Nero trial-pits were sunk in places across the narrow part of the isthmus and work was actually begun, traces of which were found when the surveys for the modern work were made, the pits being used to determine the character of the strata to be encountered. The modern work was begun in 1882.

Had the canal, even on a smaller scale, been built when Athens was the center of the civilized world, or even in the time of the Roman emperors, the shortening of the journey between Rome and Athens would have been very advantageous, but it could not be expected that a maritime canal between countries that had almost gone into decay would result in great benefit.

The distance to be saved between Adriatic and Black Sea ports is 212 miles; between western Mediterranean and Black Sea ports, 110 miles. In 1881 the Hungarian, General Turr, obtained a concession for building the canal, and work commenced in 1882.

The width of the isthmus is a little less than four miles, with deep water about 200 to 300 yards from the shore of each sea. The ground rises very rapidly, so that the cutting averages 190 feet for a length of 2 3-5 miles, with a maximum cutting of 287 feet. The line of the canal is straight. The dimensions are 72 feet bottom width, $26\frac{1}{4}$ feet depth below lowest water-level, side slopes 2 to 1 to 1 to 1 in soft soil and 1 to 10 through rock.

The eventual depth proposed was 27.10 feet, but as executed the depth was 3 or 4 feet less. Harbors were built at each end, of rubble-stone. In the Gulf of Corinth there are two converging breakwaters, 1,310 feet and 1,640 feet long, starting from shore 1,150 feet apart, and leaving an entrance 262 feet wide. In the Gulf of Ægina a single breakwater was built. Only one bridge crosses the canal, 242 feet span, 141 feet in the clear above the water, carrying a railway and roadway. The canal company must maintain a free ferry-service at each end of the canal. The old Nero test-pits gave no information about the material lying below their level, and bad sliding material developed, requiring the slopes to be flattened in rock to 1 in 5, and even 2 in 3. It was found necessary also to line the slopes with 216,000 cubic yards of masonry, from the bottom of the canal to above the water-level, along 2 3-5 miles of the central portion, greatly increasing the cost. The total amount of the material excavated was 14,260,000 cubic yards.

In 1889 work was stopped from lack of funds. Then funds were provided by the Société du Comtoir d'Escompte of Paris. This Société failed, and payments ceased; and the canal company was thrown

into liquidation. A new company, the Société Hellenique du Canal de Corinth, completed the work in 1893.

It is difficult to ascertain the actual cost of this work. The total issue of shares was \$13,750,000, but the real cost was much less.

Navigation of this canal by large vessels is hindered by its small section and steep sides. Speed is limited to seven miles per hour. The traffic since 1893 has been as follows :

	No. of vessels.	Tonnage.
1893.....	182	10,183
1894.....	2085	240,122
1895.....	2324	346,033
1896.....	2514	368,484
1897.....	494	329,063

The toll is about 20 cents per ton. The revenue in 1897 was \$60,510, and the working-expenses were \$56,275, leaving scarcely anything for interest or dividend. Loss of traffic is attributed to the Turko-Grecian war and failure to derive benefits from a tariff reduction, the Italian and Austrian maritime companies not being willing to use the canal.

The cause of the practical failure, to date, of this canal can easily be found. The advantages of shortening the route are seriously impaired by the fact that the canal is not always accessible to vessels of 23 feet draft ; by the narrowness of the channel for large ships ; and by the hard, steep sides, making it dangerous to navigate. Unfortunately there are no funds available for ameliorating these troublesome conditions.

KAISER WILLIAM CANAL.

This project was under consideration for several centuries, and was partially realized in 1777-78 by the construction of the Eider Canal, 26 miles long, which enabled vessels of 120 tons to pass between the Baltic and North Seas.

When Kiel became the great naval arsenal of Germany, the necessity, or at least the immense advantage, of securing a short and safe passage between the two seas entering German territory led to the construction of this work. The project was prepared in 1864, shortly after Schleswig-Holstein was separated from Denmark, but the wars of 1866 and 1870 delayed the work. Its construction was approved in 1886, work was begun in 1887, and the canal was formally opened in 1895. Its length is 61 1-3 miles ; the bottom width, 72 feet, with six wider passing-places ; side slopes, 3 to 1 near the bottom and 2 to 1 higher up ; minimum depth, 29½ feet. There is a narrow berm below the water-level in deep cuttings, and a wider one in low ground. The width of the water-surface is 216 and 283 feet. The deepest cutting

is 108 feet, traversing there the ridges between the rivers Eider and Zehe.

This is a sea-level canal with regulating locks at each end; it has embankments on both sides in low ground, and the slope is protected by stone pitching from $6\frac{1}{2}$ feet below the water to $3\frac{1}{4}$ above it. The sharpest curve has 3,300 feet radius, and at all curves the canal is widened, according to the curvature, from $3\frac{1}{4}$ feet to $52\frac{1}{2}$ feet. The total quantity of material removed was 105,000,000 cubic yards. There are two fixed and two draw bridges. Locks are necessary, for while the Baltic is practically a tideless sea, the North Sea at Brunsbettel has a maximum range of $27\frac{1}{2}$ feet. Two locks, side by side, allow for the passage at the same time of outgoing and incoming vessels. The lock-chambers are 492 feet long and 82 feet wide; the sills are 33-3 feet below the normal low-water level. Work was completed in the time specified, and slightly within the estimated cost of \$40,000,000.

The canal is illuminated with electric lights, placed 800 feet apart on tangents and closer on curves. Passage-time through has been fixed at 10 to 12 hours, to prevent too great wash of the banks. The distance saved between Hamburg and Bremen and German Baltic-Sea ports is 425 and 323 nautical miles, respectively, or 45 and 32 hours. The saving to Amsterdam, Rotterdam, Antwerp, Dunkirk, and English ports is about 238 nautical miles, or 22 hours; to Scottish ports, about 100 miles and 5 hours. However, British ship-owners make little use of the canal, due particularly to the shallow, narrow, and tortuous channels of the river Elbe in approaching the canal, and from the further fact that British ships must call at Copenhagen on their trip to the Baltic Sea, and because the disadvantages and dangers of the Skagen Channel, between Denmark and the Scandinavian peninsula, have been greatly reduced by buoying and lighting the channel.

Toll-rates are generally, the first 400 tons, 15 cents per ton; each additional ton, up to 600 register tons net, 10 cents; up to 800, $7\frac{1}{2}$ cents; above 800, 5 cents; with special regulations for the small German coasters and for vessels in ballast.

The traffic for 1895 amounted to 1,505,983 net tons; 1896, 2,036,861 tons; 1897, 2,345,849 tons. Receipts for 1895-96 were \$225,000; for 1896-97, \$272,000.

The canal serves the double purpose of facilitating naval operations and shortening commercial routes over an extensive area.

MANCHESTER SHIP-CANAL.

The City of Manchester, England, is situated on the Irwell, about fifty miles from the Liverpool bar. This canal avoids cost and delay

in transshipment at Liverpool. In 1882 a plan for its construction was proposed by E. Leader Williams as engineer and James Abernethy as consulting engineer, the terminus in the estuary of the Mersey to be a point opposite Garston, and the canal in the estuary to consist of low training-walls. Several modifications were made in the route and plans of the canal during the various discussions that took place in Parliament. The final total estimate on the plan before that body in the spring of 1884 was £6,904,186 12s. 6d. The plan was opposed in Parliament by the Mersey Docks and Harbor Board, on the ground that it would reduce the depth of the Liverpool bar at the mouth of the estuary; and as this view was sustained by James B. Eads, the engineers of the ship-canal changed the route so as to reach the estuary at Eastham, about six miles from Liverpool, on the south bank of the estuary. The necessary parliamentary approval was then obtained.

Locks for admitting vessels at Eastham (three in number) are, respectively, 600 feet long by 80 feet wide, 350 feet long by 50 feet wide, and 150 feet long by 30 feet wide. Four other sets of locks between there and Manchester are of similar dimensions. The total length of the canal is $35\frac{1}{2}$ miles. The total rise from the ordinary water-level of the canal at Eastham to the docks at Manchester is 60 feet 6 inches. Dividing this between the four sets of locks gives an average rise of about 15 feet $1\frac{1}{2}$ inches. All the locks are worked by hydraulic power. Railways and highways crossing the route of the canal have been raised by expensive constructions, so as to give a clear height of 75 feet for vessels traversing the canal. The remaining seven main highways cross the canal on swing-bridges. There were required in all 14 bridges. An ordinary canal was carried across by a swinging aqueduct composed of a long iron caisson resting on a pivot-pier.

This canal is excavated throughout its whole length to a minimum width of 120 feet at the bottom, and it averages 172 feet wide at water-level. The upper portion, from Barton to Manchester, is 170 feet wide at the bottom and 230 feet at water-level. At the various locks the canal is widened considerably, and vessels can be turned there if necessary. The width adopted permits large steamers to pass each other at any part of the canal, whose minimum depth is 26 feet. Sills for all the locks are placed 28 feet below water-level, to allow future deepening by dredging. Extensive docks have been constructed at Manchester, and at Warrington there is one of 23 acres. The time required for navigating the whole length of the canal is from five to eight hours.

The masonry, both brick and stone, used in the locks, basins, piers,

and retaining-walls is of the best quality, both in materials and workmanship. The total amount in cubic yards of brickwork is 175,000 and 220,000 cubic yards of masonry. The lower portion of the lock and dock walls is made of concrete, the culverts being lined with masonry of brickwork. At the water-level, granite or limestone fender-courses, slightly projecting from the face of the wall, are inserted to protect the concrete facing. The deepest cutting is near Runcorn, where, for a short distance, it is 60 feet. The cutting with the largest prism is at Latchford, where, for a distance of $1\frac{1}{2}$ miles, the depth averages 55 feet. The slopes of the excavations vary with the nature of the soil from 1 to 1 to 2 to 1. In the lock-excavations the sides are nearly vertical. The total amount of excavation in the canal and docks was about 53,000,000 cubic yards, 2,000,000 cubic yards of which was in sandstone rock. All of this waste material from the canal was used in filling up the bends of the river Mersey, which are cut off by the canal, and in raising the low lands so as to make them available for shipping, building, and other purposes. The canal was opened for operation throughout on January 1, 1894. The total cost was about \$75,000,000. The excess over the estimated cost (\$46,000,000) was largely due to the extraordinary cost of right of way:

Traffic has increased as follows: 1894, 925,659 tons; 1895, 1,358,835 tons; 1896, 1,826,237 tons; 1897, 2,066,000 tons. The total revenue in 1896 was about \$900,000.

In the first half of 1897, after meeting all expenses and making improvements, the company had sufficient surplus to pay \$183,715 interest on the first debentures and \$44,325 on the second. The capital is: \$20,000,000 ordinary shares, \$20,000,000 preference shares, and \$37,000,000 in four classes of debentures.

Facilities are not adequate to the rapidly increasing business. Grain-elevators are being erected. A large estate is being transferred into industrial plants, and commercial facilities and lines of steamers established to several points, Canada and elsewhere.

As to cost, competition, and opposition, every possible objection was thrown in the way of the work by vested interests that might suffer from the competition of the canal, especially the railways and the port of Liverpool. The former took occasion to demand the most expensive constructions in the elevation of their tracks, and when the canal was built entered into a ruinous cutting of rates from Liverpool to Manchester. Again, the towns and property-owners along the route of the canal insisted upon many constructions that have since

been found to be unnecessary, but the canal company can now look forward to increasing prosperity, and to a fair return on the investments.

There are other canals that might be described, but they hardly come under the head of ship-canals, as—

- (a) Their draft is limited, or
- (b) Their purposes are not strictly commercial, or
- (c) They are simply channels deepened by governments or cities to connect bodies of water or to reach ports. For example :

The Caledonian Canal, in the North of Scotland, with a draft of 15 feet. The North Holland Canal, with a draft of 18 feet. The Chicago Drainage Canal, connecting Lake Michigan with the Illinois and Mississippi Rivers, with a draft of 22 feet when completed ; this really forming an interior harbor for the port of Chicago and to afford a sewer. The Welland Canal in Canada, between Lakes Erie and Ontario, $26\frac{3}{4}$ miles long, and 14 feet deep. The Ghent-Terneuzen Canal, 19 feet deep and 20 7-10 miles long, from Ghent to the Scheldt. The St. Clair Flats Canal, between Lakes Huron and Erie, with a depth of 22 feet. The St. Mary's Canal, now being deepened to 21 feet, between Lake Superior and Lake Michigan. The St. Petersburg and Cronstadt Canal, $17\frac{1}{2}$ miles long, 22 feet deep.

Canals under construction or projected are :

(1) The Bruges Canal, now nearing completion. It is to be $7\frac{1}{2}$ miles long, $26\frac{1}{4}$ feet deep, and will cost, including port-works at Heyst, on the seacoast, and at Bruges, \$7,800,000.

(2) The Brussels Canal, to connect the Scheldt with Brussels and to make a maritime port of that city. This canal will be 16 miles long and 19 2-3 feet deep, so that vessels of 2,000 tons may reach Brussels. Its estimated cost is \$7,000,000.

(3) The Berlin Ship Canal, to convert Berlin into a seaport, with a depth of 25 feet and average cost of \$50,000,000.

(4) The Baltic-Black Sea Canal, 1,000 miles long, 28 feet deep ; cost estimated at \$25,000,000 ; very doubtful ; and the Canal of Two Seas, Bordeaux to Cete.

(5) The Massachusetts Maritime Canal (Cape Cod), connecting the waters of Long Island Sound and adjacent waters with Massachusetts Bay ; length, $7\frac{3}{4}$ miles ; estimated cost, \$5,000,000.

There are also the much-discussed interoceanic canals, the Panama and the Nicaragua, the present uncertain status of which as to plans and cost is so indefinite as to make it unprofitable to describe them.

By comparing the foregoing general facts concerning the great

ship canals of the world which have already been constructed, it is possible to draw some conclusions which may enable the proposed American isthmian canal to be judged upon a broad economic basis.

It has been shown that nearly all the existing canals met with opposition in their inception, and with meagre financial returns when first operated, yet who can doubt that they have been for the general good of nations and commerce? It is with great engineering works as with great political events, the very nearness prevents a true estimate of importance, and it is only when sufficient time has elapsed that the real value of any great project can be correctly determined.

Thus it was with the early history of internal waterways, with railways, and with nearly all the ship canals which have yet been constructed; and so it will doubtless continue to be with any isthmian canal, whatever route may be selected. It is only when considered in the broad light of its ultimate effect upon the welfare of mankind and the commerce of the world that a true conception of the importance of the waterway through the American isthmus can be grasped.

EDITORIAL COMMENT

One of the interesting features appearing in a monthly examination of such a collection of data of current engineering matter as is contained in the Engineering Index is the advent of notes relating to new subjects, followed by the rapid rise of interest, the influx of competing ideas, and frequently their descent and disappearance after having been a nine days' wonder. In some cases the Index contains the history, including the origin and growth of discoveries which have become classical, such for instance as the subject of radiography, from the first brief announcement of Dr. Röntgen's discovery, through the horde of followers and imitators, down to the present systematic use of the method. A subject furnishing a single note in one issue of the Index, is the source of many references by the next issue, and so the student can observe the pulsations along all the lines of engineering work by a monthly perusal of the pages of the Index. An excellent example of this is seen in the brief note of Dr. Wehnelt's electric interrupter in the April Index, followed by a number of articles on the same subject in the May issue; and a similar growth of interest appears in the notes about the Nernst lamp, as they gather from month to month.

* * *

The principal feature in mechanical engineering is the continued interest in the applications of electric driving to machine tools. Instead of questioning the feasibility of the introduction of electric driving into the machine works, the question is now rather: "On how small a machine does it pay to put an independent motor?" Not only in the machine shop, but on ship-board, on the farm, in the mine, and in fact, everywhere where power in subdivided form is required, the advantages of electric driving are beginning to be realised.

Another subject of importance to the works manager is the investigation of the various systems for compensating labour, including piece-work, the premium system,

and similar methods, together with the always present problem of cost-keeping and its allied details of factory accounting.

In view of the progress which has been made in the study of the physical constitution of materials of construction, and the influence which structural changes have upon physical properties of metals, especial interest attaches to the investigations of the properties of various metallic alloys. There is little doubt that the hitherto mysterious failures of materials supposed to be amply strong to resist the stresses to which they were subjected, might have been fully explained had metallurgists been possessed of the modern means of investigating the causes of weakness as exhibited in internal structure. Nearly every month the fruit of additional research in this field of metallurgy is placed upon record, and new methods of inspection and verification of properties follow.

* * *

One of the principal features of mining engineering, noted more fully elsewhere, is the gradual transformation of the mining of the precious metals from a gambling hazard into a methodical branch of manufacture. A gold mining claim is now surveyed, prospected, either by shafts or by drills, dredged by improved modern machinery, and fully exploited in the same business fashion as if it were a bed of iron ore, and the resulting product is known to represent the entire value which it is commercially profitable to obtain. Capital is supplied by investing shareholders, miners are employed in the same manner as labour in other industrial enterprises, and the glamour which formerly surrounded the winning of the yellow metal is obscured in a cloud of factory smoke.

The utilisation of natural sources of hydraulic power goes steadily forward, and the latest transmission in Southern California, utilises more than 700 feet head of water to generate 4,000 horse-power, transmitting it electrically at a pressure of 33,000 volts to Los Angeles, eighty miles dis-

tant from the power station in the mountains. Other installations in Utah, and elsewhere in the United States are included in the power plants indexed this month, and new projects in Switzerland, the Tyrol, and Italy, indicate Europe is not behind-hand in appreciating the value of natural power, electrically transmitted and utilised.

* * *

The international subject of ship canals is gradually attaining its true position in the public mind, and it is beginning to be seen that works of such magnitude must necessarily be of slow growth, and cannot be promoted and exploited in a manner similar to ordinary business enterprises. Viewed in the ordinary light of an investment operated for the sole purpose of returning immediate dividends upon the shares representing the capital used in the construction, the ship canal can in many cases be demonstrated to be a most unprofitable sort of a hole in which to bury good money. Considered in the far broader view of its effect upon the development of civilisation, it is beginning to be realised that the profit of such enterprises cannot be measured by a direct money value, dealt out in the form of interest or dividends, but must appear in the deeper, slower, but far more powerful influence upon the business of future years.

* * *

For a number of years there has been developing a general tendency in engineering educational institutions to consider original investigation as much a portion of their work as the mere routine of teaching, and at the present time the mechanical and physical laboratories of such institutions are in many cases the best equipped places for technical research which can be found. A noteworthy addition to this branch of engineering work is found in the new hydraulic laboratory at Cornell University, at Ithaca, N. Y., where advantage has been taken of a natural supply and head of water to construct a hydraulic laboratory rendering it possible to investigate many problems in connection with the generation of hydraulic power with quantitative accuracy and precision. The elusive subject of the flow of water may here be studied more thoroughly than ever before, and the

converse problem of the resistance of water to the motion of immersed solids can also be investigated.

* * *

Various papers upon the ventilation and warming of buildings, for large audiences, classes of pupils and individual families, contain much valuable matter. It is beginning to be appreciated that healthful warming includes the maintenance of the normal degree of atmospheric humidity, and that much of the excessive heating with dry air, so prevalent in the United States in winter, may be satisfactorily replaced by air of a lower temperature but higher degree of humidity, with manifest improvement both in healthfulness and comfort.

* * *

The development of the automobile, accompanied with the increasing use of asphalt paving, is leading to serious discussion of the possibility of maintaining clean streets in great cities by preventing the accumulation of dirt rather than by removing it after it has been permitted to collect. By far the larger part of the dirt which fouls the streets of a city, creating a frequent nuisance, and impairing the health of the residents, is due to the presence of the horse. It might be an interesting experiment to forbid all horses for a given time upon certain asphalted streets, permitting only automobiles and bicycles, in order to observe the length of time which might safely be permitted to elapse before cleaning. It is not at all improbable that the time may come when horses and other animals will be forbidden in the streets as rigidly as they are now barred from public and private gardens; all the transportation in cities being accomplished mechanically and the horse being relegated to the country, to the great advantage of both man and beast. The clean city could doubtless thus be secured, not by cleaning it, but by preventing it from ever becoming dirty.

* * *

The transformation in methods and tools in the modern machine works, brief reference to which was made in these columns last month, is a matter which cannot be studied too closely by such works managers as are desirous of keeping fully in touch with the signs of the times within their own especial province. The present

state of the machine trade in England is not unlike that of the skilled calligraphist at the time of the invention of printing. He was capable of executing the most beautiful and successful work, and he was very busy. He had heard, in a more or less indirect manner, that certain improved devices had been made which, when once prepared would produce many books in the time required by him to pen a few pages; moreover that these machine-made books would all be exactly alike, and were beautifully made at small cost. At first he did not believe these tales; then, when compelled to admit their truth, he said that such crude methods could not interfere with him, for he had more work than he could accomplish in a lifetime, and his work was not to be compared with that of such unskilled creatures as were employed upon the base art of mechanical printing. Even while he thus attempted to hold his position against the advancing tide of progress he was swept off his feet, and carried away in the flood which he could not stem, and the transformation was wrought.

It is exactly a parallel transformation which is being carried on before our eyes. Identical multiplication of innumerable articles produced by machines of marvelous perfection, adjusted and cared for by experts, but operated by ordinary tenders, is destined to replace the process of the passing system in the immediate future. And the influence of the modern machine tool upon civilisation, upon the future of society, will be no less profound than has been that of the bits of lead and the sheets of paper set in motion by the printer of Mayence, more than four hundred and fifty years ago.

* * *

The law of demand and supply, or rather of demand and supplies, holds as good in engineering matters as it does in the commercial world, and again this is being demonstrated in connection with the rise in the price of copper. It will be remembered that when, in 1888, the Secretan syndicate attempted to corner the copper market, and did succeed in forcing the price up to an abnormal figure, one of the causes which led to the collapse of the scheme was the use of substitutes for copper wherever possible. It was found, that so far from

the consumption being a fixed or increasing quantity, it became contracted far below what had been thought the lowest possible minimum, and the prolongation of the struggle thus maintained, broke the endurance of the combination.

The price of copper has been forced up again, and at the present time it has reached a point where it affects most seriously the cost of conductors for electrical transmission systems. Fortunately there is a strong competitor in the field, and at the present price of copper, aluminum is found to be an effective and economical substitute. About a year ago, Mr. A. E. Hunt showed that when the price of copper reached about one-half that of aluminum, their commercial values as electrical conductors were equal, and at the present time this fact is causing many engineers to turn to aluminum as a means of escaping the prohibitory cost of copper. Already aluminum conductors are used to advantage at Niagara, and there is no good reason why such a noteworthy example should not be followed elsewhere. Again the engineer may frustrate the schemes of the speculator, and in so doing he will undoubtedly be fulfilling once more the true function of the engineer in directing the forces of nature for the use and convenience of man, to the discomfiture of those who would repress them for his disuse and inconvenience.

* * *

There has been much foolish talk in some of the papers in the United States about the wonderful possibilities of liquid air as a source of "costless power," this having been started by a statement in a popular magazine that with ten gallons of liquid air, three gallons could be used to make ten more gallons, and so on indefinitely, and some persons really seem to have taken the statement seriously. At a recent meeting of the American Society of Mechanical Engineers, after some striking experiments with liquid air, Mr. Charles E. Tripler, who has manufactured liquefied air on a large scale, endeavored to explain this seeming paradox, and while his language to most of his hearers seemed to re-emphasise the original fallacy, yet it was evident that he meant to say that it took about three gallons of liquid air to

do the cooling for the production of ten more gallons, the balance of the work being performed by the energy of the compressor. It is one of the unfortunate results which often follows the treatment of scientific subjects by popular publications, that neither contributor nor editor is qualified to detect such errors at first glance, and it is not until an unpleasant notoriety has been attained that they become aware of the facts.

In another portion of this issue will be found a conservative and thoughtful view of the possibilities of liquid air, written for *THE ENGINEERING MAGAZINE* by one of the foremost scientists of America, Professor Elihu Thomson, and it is believed that his presentation of this important and interesting subject will contribute materially to disseminate a correct view of the probable applications of this valuable addition to the resources of the engineer.

* * *

The wide-spread interest in M. Marconi's success in telegraphing over considerable distances without communicating wires is a striking example of the way in which our estimate of the marvelous is influenced by the previous viewpoint. The fact that sound and light waves have been known to be propagated without the absolute necessity of any solid conductor is so familiar that no one considers it at all wonderful that we can hear without the necessity of a tube communicating with the source of sound, or see without an instrument between the eye and the object; but the moment it is announced that electric waves may also be originated, transmitted and received through the ether without other material connection, we all rise up and say "how wonderful!" It is indeed wonderful, even as the transmission of sound or of light is wonderful, but to the popular mind it is mainly wonderful because it has not yet had time to become familiar.

As to the possible applications of space telegraphy, these may be limited by conditions similar to those limiting the use of transmission by sound or light. As a powerful noise may drown out an oral communication, so a powerful emission of disturbing electric waves may prevent wave telegraphy from being intelligible, while the desire for privacy can hardly be as-

sured in the present state of the art, at least. It is too early, however, for the limitations of the method yet to be defined, and in view of what has been accomplished we can only speak of the immediate results.

* * *

From time to time various criticisms have appeared, either from practicing engineers, or from trustees and managers of educational institutions, concerning the entrance of professors into the field of consulting practice. The charge is distinctly made that the professor who permits himself to undertake to express his opinion upon an engineering work for a fee, is in some occult manner injuring his pupils, his fellow engineers, the institution by which he is employed, and, last but not least, himself.

It is perfectly possible to perceive how, in some instances, this view of the case may be entirely well founded, for professors are not unlike other men, and will, upon occasion, neglect their duty, but such cases should stand on their merits, or rather on their defects, and not be made a cause of condemnation of the great majority of instances in which the reverse is true. One of the greatest defects of technical schools, otherwise excellent, lies in the absence of close touch of the professors with contemporary, active practice, and the students enter upon their work after completing their courses only to find that they have been taught by a lecture room instructor, himself the successor of a similar unpractical teacher, with much to learn and more to unlearn.

Those who observe this matter from an impartial standpoint, cannot fail to note the live, active methods of the professor who not only enters into the external practice of his profession, but takes his students into it with him as assistants; and there is no better training possible for the pupil than thus to be initiated into the real field of work which he is afterwards to occupy. The man who, in such practice would neglect his true duties towards his pupils and his institution, is obviously unfit to hold a position of trust and responsibility in any case, while a professor who can command the conduct of responsible professional work should be considered doubly desirable as an instructor.

REVIEW OF THE BRITISH PRESS

Safety Mining Explosives.

IN view of the increased attention which is being given to the prevention of accidents in mining, and especially to the avoidance of explosions of fire damp, the paper of Mr. Oscar Guttman, recently presented before the Society of Chemical Industry, and printed in the *Colliery Guardian*, is especially timely, treating, as it does of the principles which lie at the foundation of safety in mining explosives.

The numerous tests which have been made in England, France, Austria, and elsewhere upon the ignition of pit gas have shown that two requisites must be fulfilled in order that an explosive may ignite the gas. In the first place a high enough temperature must be produced, and in the second place the duration of the heat must be long enough. Hence ignition may be prevented either by causing the temperature to be kept down, or by increasing the rapidity of the explosion to a degree affording insufficient time for the gas to ignite.

Pit gas consists of about 95 per cent. of marsh gas, or methane, and mixtures of air containing from 6 to 10 per cent. of methane form a dangerously explosive mine air, against the ignition of which every practicable precaution should be taken. According to the tests made by the French commission, it was found that the pit-gas mixture must be heated to a temperature of 650° C. before it will ignite, and that even then the source of heat must continue to act for at least ten seconds, in order to produce inflammation. Thus it is possible that a flame acting for a short time only, such as that produced by the detonation of an explosive, may have a much higher temperature without producing ignition. Some of the experiments showed that with rapidly detonating explosives a temperature of 2,200° C. was required to produce ignition. The comparative slowness of the combustion of gunpowder renders it necessary to provide some means of preventing the heat from

reaching the gas, while the high temperature of some of the rapid explosives unfits them for use in gas-laden workings.

The earlier methods of rendering blasting explosions free from danger involved the use of some form of protecting jacket. Among these may be mentioned the water cartridge, in which the explosive is surrounded by a jacket of water. This is undoubtedly safe, but is inconvenient, and requires a large borehole. Tamping with wet moss or with damp clay gives good results, while a fair degree of protection is obtained by the use of a tamping of dry sand. The very general use of explosives other than gunpowder, however, renders protection of this sort less desirable than the restriction of permitted explosives to those unable to produce ignition. The requirements in Austria are that the material should explode with a short, but not bright flame, and, when used up to a certain weight, should not ignite mixtures of fire-damp and coal dust. In France the requirements are that the products of the explosion should not contain inflammable substances, and that the temperature of the explosion must be below 1,500° C. In England there is no especial definition, each explosive being required to undergo test at Woolwich before its use is permitted.

While the above requirements are in general well adapted to insure safety, there are some exceptions which should be taken into account. In general it is correct to assume that the ignition of fire-damp depends directly upon the temperature of the explosion, but it has been demonstrated that, by increasing the weight of the charge, certain explosives cease to be safe, notwithstanding the fact that the temperature limit has not been exceeded. There appears to be a "breaking point" with each explosive, forming a limit of quantity which may be safely used, and it is not improbable that when this point is reached the force of the explosion acts in a manner similar to compression in a gas

engine, lowering the ignition temperature and changing the conditions to a marked degree. Extreme rapidity of explosion is also open to objection, probably for a similar cause to that existing with large charges, the force of the concussion changing the conditions, and the safest method is to use moderate charges of explosives producing temperatures low enough to be altogether incapable of igniting the gas.

Much expense has been incurred in the construction of trial galleries, and in experiments with various gas mixtures, both natural and artificial, and in the light of the results which have thus been obtained it is possible to limit the use of explosives for blasting in gaseous workings to such as by composition and action are free from material danger.

Mr. Gutman's paper gives many interesting details with testing, and discusses also the use of detonators, and of various materials for cartridges, and is altogether a valuable contribution to the literature of the subject.

The Performance of Refuse^o Destructors.

THE disposal of town refuse by incineration is by no means a new method, but of late there has been much discussion as to the possibility of utilising the heat evolved during the combustion to any advantage. The results obtained at Shoreditch are largely responsible for the present interest in the subject, and precise data about other installations are welcome additions to the store of practical knowledge in this important branch of sanitary engineering.

From a report recently submitted by Lord Kelvin and Professor Archibald Barr upon the working of the Horsfall destructors at Edinburgh, Bradford, and Oldham, some valuable information may be obtained, the report being published in *The Engineer*, with tables of the results, and illustrations showing the construction of the furnaces.

While there are several fundamental principles which should be observed in the design of refuse destructors, it is always desirable that the special nature of the refuse to be disposed of in any given case be taken into account in construction of the furnaces. Although the primary object in view is always the sanitary one, it is also

desirable to obtain as large a thermal efficiency as possible and it is entirely practicable to unite both features in the highest degree if proper precautions are taken. In order that all noxious and deleterious matter shall be fully and completely destroyed it is essential that a high temperature be maintained, and this requirement is also favourable to the economic utilisation of the heat produced. The high temperature is necessary not only in the furnace where the solid refuse is burned, but also in the flue through which the discharge gases are passed, in order that all gaseous hydrocarbons may be fully consumed, and neither smoke nor offensive gases discharged at the chimney top. The best combustion is attained in the furnace when the feeding door and discharge flue are so placed that the gases distilled from the raw material shall pass over the hottest part of the furnace on their way to the main flue and be brought quickly into contact with the intensely hot gases arising from the previously dried and incandescent material upon the grate bars. A forced draught is necessary to maintain a powerful combustion on the grate bars, and in the Horsfall destructor this draught is produced by steam jets. The steam, being condensed serves, by re-evaporation, to protect the grate bars, and is subsequently decomposed in passing through the bed of incandescent refuse, thus producing water gas, which is burned by the excess air over the fire, serving to increase the temperature which would otherwise exist at the meeting of the products of combustion with the gases distilled from the raw material.

The destructors are best arranged in series, all delivering into one flue, so that the brickwork in the flue is always kept very hot while the clinker is removed from the cells in rotation. When the fire in one cell is green, the other cells will be discharging hotter products, and thus the temperature of the flue will at all times be maintained sufficiently high to prevent any noxious vapors from reaching the chimney.

The utilisation of the heat produced by the incineration of the refuse is accomplished very simply by placing steam boilers in the flue in such a manner that the

intensely hot gases, already fully burned, come in intimate contact with the heating surface of the boilers. For this purpose water-tube boilers have been found very effective and a large portion of the heat is thus converted into a form available for use for power, electric lighting, or whatever may offer the best returns. The refuse at Oldham gives a steam production equivalent to the evaporation of $1\frac{1}{3}$ pounds of water from and at 212° F. per pound of unscreened refuse treated, and it is believed by Lord Kelvin and Professor Barr, that, in a plant designed to utilise the heat to the fullest extent, an evaporation of $1\frac{1}{2}$ pounds of water per pound of refuse, or even more, could be reached, and that without in any way affecting the perfection of the process from a sanitary point of view. According to these figures, the Oldham refuse has a fuel value of about one-seventh that of good steam coal. From the tables accompanying the report it appears that the Oldham refuse produces about 33 per cent. of clinker, one cell having a capacity of eight tons of refuse for every twenty-four hours. Analyses of the gases discharged at the chimney show the presence of only nitrogen, oxygen, and carbonic acid, there being no carbonic oxide nor hydrocarbons discharged.

The report contains much valuable information for designers of refuse destructors, and in view of the high reputation of the authors, it must be regarded as a valuable contribution to the science of sanitary engineering.

Steam Piping.

It has been well said that with the great advances which have been made in the construction both of steam boilers and engines there has by no means been a corresponding improvement in the connections between these two great branches of a power-plant. The truth of this statement is substantiated by the frequent failures of steam pipes, and the general trouble which is experienced with steam connections.

A paper recently presented before the Institution of Naval Architects by Mr. J. T. Milton gives a valuable and instructive discussion of this important subject, and although the matter is considered from the

standpoint of the marine engineer the facts and conclusions are very generally applicable.

Taking as a basis the record of the failures of steam pipes and connections since 1882 some interesting lessons may be learned.

Very few pipes have given way because of defective thickness or of original weakness, nearly all of the trouble having arisen from conditions which might have been avoided in erection and use, or else from the influence of changes due to high temperature, expansion and contraction, or some similar force. In fourteen out of sixty-eight cases the accidents occurred through the absence of any provision for draining away condensed water from the pipes; while in no fewer than thirty-eight, or more than half the total number of accidents, there was insufficient provision for expansion and contraction, and for the motion due to vibration, and in but few cases did explosions occur through original defective workmanship or through subsequently developed defects.

Formerly the main steam pipes of vessels, as well as the smaller pipes, were made of copper, with brazed seams, but of late the difficulty of securing brazing which would stand the corrosive action of fatty acids under the influence of the high temperatures accompanying modern high steam pressures, has led to the adoption of seamless drawn tubing, which can be bent into the desired curves.

The original use of copper was doubtless due to its supposed resistance to corrosion, and its ductility, by which it was possible to make connections in almost any direction after the machinery was in place, without careful preliminary fitting. An element of uncertainty in connection with the use of copper piping lies in the effect which hardening has upon the extension and apparent strength, and all tests of material for this purpose should be made only after careful annealing. The diminution in strength which copper shows at the high temperatures of steam now in general use, is also a serious objection to this material, and it is a common precaution to reinforce copper pipes by wrapping them with steel or copper wire, or by fitting wrought-iron bands at short

distances apart throughout the whole length.

Modern practice, however, discards copper for main steam piping, using instead lap-welded iron or steel, the connections being made by flanges either welded or screwed on. When wrought iron or steel pipes are used the designs are generally made so that individual pipes are straight, or nearly so; although if necessary, bends of reasonable radius can be made. It is generally possible, however, to lay out the connections so that straight pipes will serve, and with proper supports, and well-made expansion joints, the pipes may be relieved of all stresses except those due to the pressure within.

Hydraulic tests of such pipes show that the bursting strength is far above the working pressure, and hence the principal care should be proper provision against external and unnecessary forces. This involves the important matter of the methods of supporting long lengths of pipes. The supports should be so arranged that while holding the pipe to its proper place and preventing vibration they will not of themselves prevent the movements due to expansion and to that of the boilers. Expansion joints should be firmly fixed and supported in position, so that the motion due to expansion and contraction will be made by the pipe, and taken up entirely by sliding in and out of the packed stuffing-box.

With carefully planned piping of steel, judiciously supported, and with ample provision for meeting expansion stresses, there is no reason why the connections between boiler and engine should give more trouble, or be a greater source of danger, than any other part of the machinery.

Telegraphy Across Space.

THERE has been much talk of late about the experiments in telegraphing across distances of many miles without the use of conducting wires, and the experiments of Marconi, both in Italy and in England have attracted much interest.

In a paper recently presented before the Institution of Electrical Engineers, M. Marconi has stated his position and work very fully, and some extracts and comments may be of interest. In the first place, M. Mar-

coni frankly states that the theory of the method used by him is that due to Hertz, and that the coherer by means of which the reception of messages is made possible, is due to the discoveries of Questi, Branly, and Lodge, and only claims for himself the perfection of the details which have made the transmission of telegraphic messages over distances of twenty to thirty miles without wires a practical success.

After explaining the constructive details of his apparatus, M. Marconi called attention to the especial details which have enabled the distance gradually to be increased between the transmitters. The most important feature is that of the elevation of the apparatus above the surface of the earth. With the increase in elevation an increased range was invariably obtained, and the experiments seem to indicate that the distance at which signals can be transmitted varies approximately with the square of the distance of the capacities from the earth. Other things being equal, a vertical wire 20 feet long at the transmitter is sufficient for communicating one mile, 40 feet at each end for four miles and 80 feet for 16 miles, and so on. M. Marconi has made experiments both with and without reflectors, with the idea of controlling the direction of the waves, and preventing them from reaching receivers for which the signals were not intended, and although he has obtained some success with the reflecting apparatus it has only been over comparatively short distances, under two miles; all the long-distance work having been done without reflectors.

While it is too soon to predict the extent to which space telegraphy will find application, some of the experiments of Marconi have fully demonstrated its use for communicating between vessels and the shore, and it is probable that the general adoption of the apparatus upon all vessels would do much to prevent collisions in time of fog.

The Wastefulness of Steam Auxiliaries.

EVER since the experiments made upon the steam consumption of the auxiliary machinery of the United States cruiser Minneapolis there has been more or less discussion as to the best methods of securing higher economy in the important depart-

ment. The paper presented by Sir John Durston at the recent meeting of the Institution of Naval Architects upon the trials of H. M. S. Argonaut furnishes additional information upon the high steam consumption of the auxiliary machinery, fully confirming the results obtained by Mr. White in the case of the Minneapolis.

The Argonaut was especially fitted up for her trials with apparatus for determining the water consumption of the engines, special measuring tanks being provided for this purpose, and although no especial appliances were used for the auxiliaries, the relative proportion of steam used by the auxiliary machinery as a whole was determined in a satisfactory manner. All the condensed steam delivered from the main condensers was measured in one set of tanks, while that from the separate condenser used for the auxiliaries was measured independently, the percentage of steam consumption of the auxiliary machinery being thus accurately determined under various conditions.

As might be expected, the proportional consumption of steam due to the auxiliaries was much greater when the main engines were running at reduced power than when the full power was exerted, the auxiliary machinery taking nearly as much steam at one time as at another. Thus when the main engines were operated at 3,600 indicated horse-power, the auxiliaries required about 22 per cent. of the consumption of the main engine, while when the full capacity of 13,500 horse-power was developed, the auxiliaries required only 10.4 per cent. of the main engine consumption. This is an especially important matter, as it shows what a close relation the auxiliary machinery bears to the coal consumption at low powers. Much attention has been given to various means for attaining high fuel economy when cruising at low power, while at the same time this conspicuous source of loss has been neglected.

It is expected that light will be thrown upon this important subject in connection with the trials of the Amphitrite, as especial experiments are to be made with a view of securing the advantages of triple-expansion in the working of the auxiliary machinery.

As described in *Engineering*, various

plans have been made to obtain a higher economy in the auxiliary machinery. The heavy duty required of the feed pumps demands a high pressure through nearly the full stroke, and results in a correspondingly high terminal pressure, and instead of delivering this exhaust steam directly to the condenser it is proposed to use it in the centrifugal pumps, the exhaust from the feed pumps being discharged into a receiver from which the engines of the centrifugal pumps are fed. After the steam has passed the centrifugal pumps it will be delivered to the distiller, and the exhaust steam from the other auxiliaries will also be discharged into the distiller, in which no live steam from the boilers is to be used.

While the economies to be effected by improvements in steam auxiliaries are undoubtedly great, there is some question as to the use of steam machinery for this purpose at all. The advantages of electric driving in subdivision of power have been so fully demonstrated in stationary plants that it seems desirable to consider the general use of electricity on shipboard for all such purposes. A single economical electric-power plant could be operated to far greater advantage than the numerous small engines now employed for auxiliary purposes, and instead of endeavouring to improve the present method it has been seriously suggested to replace all the steam auxiliaries with electric motors, leaving only the main propelling engines and the electric generating plant to be operated by steam. Whether this solution of the problem will meet all the requirements remains to be seen, but it is an experiment which may be tried before very long.

Modern Machine Tools.

AN interesting paper presented before the Glasgow Association of Students of the Institution of Civil Engineers by Mr. Joseph Shepherd upon modern machine tools, led to a still more interesting discussion, since it brought some of the conditions under which modern tools, be they English, German, or American, must be operated if full value and product is to be obtained from them.

Mr. Shepherd began by comparing the activity existing in other countries in re-

spect of replacing antiquated equipment with modern automatic machinery, affirming most distinctly that if England did not awake from the stagnation existing at present, a period would soon arise when she would be in great danger of being squeezed out of the world's mechanical trade. Speaking as a tool user, and not as a tool-maker he selected from among many others, the turret lathe, and emphasised the importance of remembering that no judgment on the part of the operator was necessary, all the tools being set in the correct relative position needing no change or attention except for grinding. In such machines no measurement of work is necessary, the operations being purely mechanical, and requiring little or no skilled attention.

Reference was also made to the wholly automatic screw machines and to the heavier chucking machines, and the speaker then proceeded to show how the full advantage of such machines could only be obtained by a proper systematisation of products, so that pieces would be made in lots of not fewer than 50 to 100 at a time, while the labouring force should also be divided into the unskilled operators, caring each for a number of machines, and into skilled mechanics in a tool room, with the sole duty of the manufacture, care and storage of tools.

The discussion of the paper emphasised some of Mr. Shepherd's points very forcibly, it being shown that in order to utilise such machines efficiently it would practically be necessary to reorganise the workshops entirely. That this has not been done before is due to a variety of causes. It is the too common practice of the majority of users of mechanical products to insist on variations and modifications of these products to suit their own views. This prevents the manufacture of products in sufficient quantity to permit such duplication as alone can render automatic machinery valuable. The variety of products made in many works interferes with successful duplicate work, while until very recently the opposition of workmen to the employment of unskilled labour to produce articles formerly made only by skilled mechanics did much to prevent the introduction of modern tools.

Many establishments, also, have been too busy and successful under the old system to desire a change. Wealth of work and want of foresight have lulled the producer into the desire of taking as much as he possibly can out of his shop in the shape of present profits, in preference to an investment in new appliances and a deferment of profits. In the light of present experience, and still more in view of rapidly approaching competition, this cannot but appear as a blind consumption of capital, since the supposed profits have really been made at the expense of a depreciation of plant which has absorbed principal far more rapidly than the owners imagined.

There is little doubt that this whole question of modern machine tools is bound up very closely with the broader subjects of works organisation and the subdivision of labour, and with these comes also the necessity of considering the importance of specialisation in products, enabling skill and attention to be concentrated upon a limited variety of duplicate work and permitting the time cost to be enormously reduced while the quality of the product is at the same time greatly improved.

The Failure of Propeller Shafts.

DURING the past year there has been an increasing number of failures of the shafts of screw propeller engines, and in consequence numerous discussions have followed as to the causes and remedies for such a serious state of affairs. Two papers, recently presented before the North-east Coast Institution of Engineers and Shipbuilders, by Messrs. Frank Caws and E. C. Chaston, cast much light upon the causes for the increase in shaft failures and point out some of the possible remedies.

There are two causes for shaft breakages, excessive stresses and defective workmanship, and in the papers referred to Mr. Caws treats mainly of the nature and causes of the severe stresses which propeller shafts are called upon to sustain, while Mr. Chaston deals almost entirely with defective methods of construction and workmanship.

Considering first the heavy duty re-

quired of screw propeller shafts, there is little doubt that this has been increased of late in the cases of the large number of leviathan tramp steamers which have been built during the past few years. These large vessels have been constructed for the reason that they are more economical, both from the increased capacity and because of the proportionally reduced amount of engine power required. The result has been the introduction of many ships of large displacement and moderate powering, conditions which, however favourable to commercial transport, approach closely to the danger line so far as the strength of the shafting is concerned.

In the first place, the accepted rules for proportioning the size of the propeller shaft make the strength of the shaft depend entirely upon the power of the engines, this being true both for the rules adopted by Lloyds and by the Board of Trade. If the vessel were to be propelled steadily through smooth water, this would undoubtedly be correct, but the stresses due to propulsion are by no means the most severe to which the shaft is subjected.

The tossing and rolling of the ship, due to the action of the waves, throw many sudden and severe stresses upon the propeller and shaft, and as these do not originate with the engines, the powering of the vessel is no measure of such stresses; they are rather measured and determined by the inertia of the ship's displacement mass. The greatly increased size of modern freighters and their proportionally lower powering emphasises this discrepancy between stress and strength, and points clearly to the fact that greater strength is necessary for propeller shafts than is indicated by the power of the engines. Long vessels are also more flexible than shorter ones, and thus another disturbing element is introduced into the computation. Of course it is impossible to avoid flexure in the hull of a vessel, and under such conditions great stiffness in the shaft would only create still more injurious stresses, for under no circumstances can the shaft be expected to stiffen the hull.

What is really needed, therefore, is not the maximum of stiffness, so much as the maximum of harmony between the flexibility of the ship and her shaft. In many

cases the injurious stresses on a shaft are intensified by imperfect fitting. As Mr. Chaston points out, this is often due to the common practice of boring out the coupling bolt-holes, and fitting the coupling-bolts on the floor of the shop, instead of finally reaming the bolt-holes and fitting the bolts in the shaft when it is in position in the ship afloat, as was formerly the practice. Numerous instances are cited where shaft breakages are directly traceable to this cause, and where injurious strains upon bearings have been entirely removed by refitting the couplings.

Defective material is often thought to be a cause of shaft breakages, but as a matter of fact this is very rarely the case. The very thorough inspection to which every shaft is subjected is sufficient to detect any serious flaw which may have developed during the forging, and the supervision, both of the Lloyd's inspectors and the skilled mechanics engaged upon the work of turning and finishing, is the best protection which can be had against defective workmanship. Added to this may be mentioned the improvements which have constantly been made both in material and methods, so that it may safely be assumed that in nearly every case propeller shafts are fully as strong as their dimensions indicate, and that breakages are due to stresses which they were never proportioned to sustain.

In many cases shipbuilders have voluntarily increased the proportions of propeller shafts beyond that required by Lloyd's rule, but the exercise of such discretion can hardly be expected in all cases, and it is heartily to be desired that some more rational expression for the computation of safe proportions for such important members be determined and enforced.

The Measure of Horse-Power.

THE use of the unit horse-power for measurement of the power developed or required by any particular example is probably too firmly rooted to be disturbed to any great extent, but it is desirable for many purposes that its various synonyms be known and used. An interesting article in a recent issue of *The Engineer* deals with this subject, in a rather pleasant vein, bringing out at the same time some

features in connection with power computations which will bear repeating.

The general idea of the horse-power as consisting of a definite number of foot-pounds per minute is the fundamental conception, and there is little doubt that by far the greater number of engineers compare other rates of work with the horse-power by reducing them to foot-pounds per minute before making the comparison. As a matter of fact, the foot-pounds per minute idea is but one of many equivalent expressions, all of which are equal to the same development or expenditure of power, and it is sometimes very convenient to be able to avoid the intermediate reductions in converting the one into the other. For this reason the writer of the paper referred to gathers these equivalents, and classifies them into groups, as: Elementary; Hydraulic; Thermal; and Electrical. These are tabulated in connection with the time units of the hour, minute, and second, and a very convenient set of constants is thus obtained, expanding the familiar 33,000 foot-pounds per minute into such expressions as: 375 mile-pounds per hour; 4,500 kilogrammetres per minute; 42.42 Fahrenheit heat units per minute; or 746 kilowatts per second, etc.

In view of the widening scope of methods of power generation some of these values for the horse-power should come into very general use, as indeed the electrical equivalent already has done. The extending use of power gas and of fuel gas renders it very desirable that the thermal

equivalent of a given gas in heat units for any given volume consumed per unit of time, may be converted directly into its horse-power value, and similar conversions in connection with water power are of frequent use. For purposes of comparison there is little doubt that the expression of the duty of a steam engine in thermal units possesses numerous advantages, although, as is plainly pointed out, there is no physical difference between the two statements of the measurement, the only actual difference being a purely arithmetical one, as indeed is the case with all of the equivalents. There is, however, a vast convenience in dispensing with the intermediate arithmetical labour, beside the removal of some source of error, and the term horse-power has now gotten so far away from Watt's experiments with animal power that the origin of the term is hardly ever conveyed by the name.

"It is to be hoped that there may never come upon us any movement in favor of the use of a variety of physical units of horse-power—that is, of horse-power units of really differing physical quantity. In English linear measures we use the units the inch, foot, yard, and mile, and the result is great inconvenience and unnecessary labour. As regards rates of doing work, we have already two great unit measures—horse-power and kilowatt. It is greatly to be desired that no further diversity than this already established duality of measuring unit should be introduced."

REVIEW ^{OF} _{THE} CONTINENTAL PRESS

The Gas Engine and the Smoke Problem.

EVER since the introduction of soft coal as fuel, the smoke problem has been with us, and with the enormous growth of power plants and manufacturing establishments within municipal limits, the production of smoke has in many instances become a nuisance for the abatement of which legislation has been invoked. In Paris a systematic series of trials has lately been concluded in order that the authorities might know to what extent smoke prevention was practicable, and in Philadelphia, the Board of Health caused the subject to be investigated most thoroughly by the Franklin Institute, with the same end in view.

Most of the remedies which have been suggested for the abatement of the smoke nuisance are based upon the more thorough combustion of the coal, either by regulating the admission of air in the furnace, or by more effective intermingling of the air and gases during the operation of combustion, and while it has been demonstrated that with proper care soft coal can be burned under boilers with the production of little or no smoke, it has also been clearly established that there is no especial economy in so doing, and that any efforts to induce owners to install apparatus for smoke prevention must be for public benefit without including any advantage to those by whom the expense is borne.

Another method for the abolition of the production of smoke in power generation is discussed by Herr Joh. Korting in a recent issue of the *Zeitschrift des Vereines deutscher Ingenieure*, this being also a method which involves a marked economy in power generation as well.

The high economy of the internal combustion motor, either in the form of a gas or a petroleum engine is well known, and even the least economical gas engine is far beyond the performance of the best steam engine possible, while the later forms of internal combustion motor show a thermal efficiency several hundred per cent. of that of steam engines of the same size and

power. When it is remembered that all these gas and petroleum motors are absolutely smokeless in their action, it appears that it is along this line of power generation that the complete solution of the smoke problem must be made.

Assuming that these facts are accepted, Herr Korting discusses the subject from the very practical side of cost, both of installation and operation, taking the Korting gas engine as a typical gas motor, and the Diesel motor as a petroleum engine, and by means of comparative curves shows the relative cost of power from these sources; using illuminating gas at various prices, as well as power gas in the gas engine, and fuels of various costs in the Diesel motor. Curves for simple and compound engines, with and without condensation are also given, the capacities extending from 10 to 400 horse-power, the diagrams thus enabling the relative economy of the different motors to be seen at a glance.

So far as operative economy is concerned the gas engine, when operated with fuel gas shows a decided commercial advantage over steam at all powers, although the gain is less at the higher power than for the smaller sizes. This, however, is not because the gas engine is less economical at large power than at small, but because the wasteful performance of small steam engines is proportionately greater. The commercial economy of the petroleum motor is by no means so great as its thermal efficiency would indicate, this being due to the cost of the fuel, and as producer gas can be made from very cheap and inferior fuel, this compensates for the somewhat lower thermal efficiency of the gas engine.

The principal hindrance to the general introduction of the gas engine as a substitute for steam power lies in the fact, that, as yet, but little experience has been had with the larger sizes. That the large gas engine is an assured certainty, however, is the opinion of the best informed experts in this line of work, and in the pages of

this magazine, a little more than a year ago, Mr. Dugald Clerk said: "There can be little doubt that in ten years, gas engines of 1,000 horse-power will be as common as engines of 100 horse-power are now." In view of the fact that a successful Westinghouse gas engine of 750 horse-power has already been constructed, it appears that the capacity given by Mr. Clerk may be reached in a shorter period than ten years, and in any case the large gas engine will undoubtedly make its appearance on a commercial scale so soon as a strong enough demand shall have been created for it.

This demand, according to Herr Korting may appear at first, not in the form of a requirement for great economy, but from the enforcement of legislation against smoke-production, and when it is realised that the highest known economy includes with it absolute freedom from the production of smoke, the importance of the internal combustion motor will be doubly emphasized.

The Traveling Sidewalk at Paris.

THE idea of a traveling sidewalk is by no means new, as it had been suggested several times before it was practically tested at the World's Fair at Chicago in 1893, and since then another successful installation has been made in Berlin. These examples, however, were but small affairs compared with the very extensive plan proposed for the Paris exposition by M. de Mocomble, concerning which notes have already appeared in these columns, and a full description of which was given in the March issue of THE ENGINEERING MAGAZINE. The proposed sidewalk for the Paris exposition is to be so much larger than any of its predecessors, being 5 kilometres in length (more than 3 miles), that the exposition authorities thought best to require the contractor to construct a preliminary section, and show it in full operation under severe tests, before his plans should be finally accepted.

This preliminary trial has now been held, and from a fully illustrated account in a recent issue of *Le Génie Civil* the results are obtained. This trial platform was constructed exactly as the plans had been made for the final scheme, with the exception of

the length, the experimental section being an oval of about 410 metres perimeter (1,350 feet) with a short re-entrant curve on one side, in order to test the behaviour of the mechanism under such conditions, and a slight grade of 0.3 per cent, at two points.

The sidewalk consists of three parallel platforms, the outer one being stationary, the next having a speed of 4 kilometres, and the inner one a speed of 8 kilometres, per hour. With these speeds it is found very easy to step from one to the other at any point, so that all delays from stoppage for entrance are eliminated, and this fact, together with the enormous carrying capacity, renders the moderate speed ample for prompt conveyance to any part of the line.

Each of the moving platforms is composed of 32 sections, with semi-circular ends, there being short intermediate sections between each of these, with ends shaped to fit, so that the entire circuit is covered, and no joint is opened as the platform bends and straightens. The platforms each have their own tracks and independent electric motors, a three-phase current of 600 amperes, and 220 volts being provided by a dynamo of the Alioth type.

The practical results of the trials of this preliminary apparatus were very satisfactory, although some defects were revealed, which can be avoided in the final structure. The sidewalk was operated successfully in very unfavourable, snowy weather, carrying more than 1,500 persons at once; the total weight of the platforms, in this case being 250 tons, and the power absorbed varying from 40 to 45 kilowatts. A variation of 60 tons in the load produced a corresponding variation of about 5 kilowatts in the energy required for propulsion. Experiments were also made by loading the entire platform with pig iron to 400 kilogrammes per running metre (252 pounds per running foot), and also by applying a concentrated load of 50 tons upon a single section, without producing any injurious effects.

The trials showed that no difficulty was experienced, even by persons possessing little agility, in stepping from the stationary platform to the moving sections, it only being necessary to step *with* the moving platform. The only serious objection which the trials revealed was that of undue noise, caused by the slippage of the axial girders

of the moving platforms against the stationary driving wheels. This objectionable feature, it is believed, will be obviated in the completed platform of the exposition, the experience with this temporary structure having shown it in time.

There is no doubt that this traveling sidewalk will remedy to a great extent the inconvenience which would otherwise have been caused by the distances which separate portions of the exposition, as it will practically connect all parts of the Champ-de-Mars with the Esplanade des Invalides and the Quai d'Orsay, and although it cannot be extended to the right bank of the Seine, yet it will deliver passengers to the entrance of the Alexandre III. bridge and enable them to reach the Champs Elysées simply by crossing the river.

The principal criticism which has been made of the plans of M. de Mocomble is the momentum which will be acquired by such a large, continuously moving mass, and the liability to serious dislocation of the whole, should any sudden stoppage occur. It must be remembered that the total weight will not be materially greater than that of many freight trains, in the United States, at least, which are hauled at greater speeds, and are successfully managed without difficulty from this cause.

Reinforced Concrete.

THE extremely rapid development of the use of concrete reinforced by imbedded metal in construction renders it almost impossible to keep pace with the applications except by maintaining a close watch over the recorded accounts in the technical press. In the current journals we have two notable papers upon this subject, one being a very thorough discussion by Professor Ritter, in the *Schweizerische Bauzeitung*, of the Hennebique system and the other an account in *La Revue Technique* of the curious and very economical X shaped bridge at Mans, this latter paper being practically an investigation of the entire subject by M. Harel de la Noë, Chief Engineer of the Ponts et Chaussées.

The close relation existing between these two articles renders it desirable that they be reviewed together, forming as they do a joint discussion of both the practical and theoretical sides of the subject.

The possibility of using iron and concrete in combination depends upon several important properties, the truth of which has been demonstrated experimentally beyond doubt. These properties are: 1, that the coefficients of expansion of iron and cement are practically equal; 2, that cement adheres very strongly to iron, the German experiments indicating 45 kilogrammes per square centimetre, (640 pounds per square inch); 3, that concrete possesses enough elasticity to allow it to stretch, without cracking, to an extent sufficient to permit the tension stresses to be sustained by the imbedded metal.

As is well known the Monier system of reinforcing concrete is by means of imbedding a network of interwoven wire, while in the system bearing the name of Professor Melan, rolled beams, or even lattice girders, either straight or arched, are used as a sort of skeleton about which the enclosing mass of concrete is moulded.

The Hennebique system, used to some extent in Switzerland, lies midway between these two, but is somewhat simpler than either. It uses as a reinforcing material, round iron rods, ranging from $\frac{3}{8}$ inch to $1\frac{1}{2}$ inches diameter, these being so placed as to be as far as possible from the neutral axis on the tension side, and interlocked with the whole mass of concrete by so-called stirrups of flat iron bent in U form about the rods, with the open end extending up into the concrete. Such a system of rods and stirrups when used in connection with concrete made from first-class cement enables flat floors to be made without any arching or other support between beams, with a sustaining power of 200 to 400 pounds per square foot, and a similar arrangement permits arches of great strength to be constructed very cheaply and rapidly. Professor Ritter goes very fully into the relative proportions to be observed between the section of the rods and the concrete, and shows how the strength of the combination may be computed in a simple manner.

The double bridge at Mans is noteworthy for its form, as well as its mode of construction, there being really two bridges in the shape of a letter X, the intersection being in the middle of the crossing of the River Sarthe. One portion of this combi-

nation carries an electric tramway and the other half of the X is for a local steam railway from Mans to St. Denis d'Orques. This peculiar necessity of construction was complicated by the fact that the limited funds available made it necessary to keep the entire cost of the work down to 45,000 francs, or about 90 francs per square metre, while the Pont Ysoir, which crosses the Sarthe within a few yards of the new bridge, cost 288 francs per square metre, not including the foundations.

Under these circumstances recourse was had to reinforced concrete, as offering the best method available for obtaining a reliable structure at a low cost, and the result has fully justified the wisdom of the course. The new bridge is substantial, both in appearance and in fact, and is not inartistic in effect, while the actual cost, including foundations and piers, was only 33,000 francs, or 66 francs per square metre!

This low cost was partly due to the use of old rails as a material for reinforcement of the cement, and the success with which this material has been used in this case will doubtless lead to a repetition of the practice elsewhere. The piers consist of a foundation of a grille of rails laid crosswise, and buried in concrete. Upon these were erected hollow pillars, made of blocks of concrete, with four rails placed vertically in the interior space, with cross cramps of flat iron interlocking them to the outer blocks, the whole interior being then filled with concrete, run in so as to bind the whole into a firm mass.

The superstructure is composed of built-up girders, resting upon the piers, the flooring being composed of transverse arches turned between cross beams of imbedded rails, the whole forming a very strong, effective and substantial structure.

One of the most economical features of the system of reinforced concrete lies in the ease with which simple materials can be utilized, while the absence of carefully fitted connections, and of much detail of erection work, tends greatly to eliminate expense.

There is little doubt that this form of construction, in some of its many varieties, is destined to enter very largely into future work in many places, and for ease of erection, moderate cost, and security against fire, it has much to recommend it.

A Unique Water-Works.

THERE has recently been completed at the little seaside village of Yport, on the French coast of the Channel, a water-works plant, which, although quite small, is most interesting, and from an account in *Le Génie Civil*, some of the peculiar features of the installation are abstracted.

The source, or rather sources, of the supply are a series of springs, situated on the pebbly beach at the foot of the chalk cliffs, and entirely covered by the sea to a depth of more than 10 feet at high tide, while as the tide falls the pure water flows up forming bubbling pools several metres in diameter, like the discharge of a submarine river through the gravel of the beach.

The water from these springs has been entrapped in small intake reservoirs built in the rocks, protected against the entrance of sea water, and filled by the fresh water as the springs are uncovered by the falling tide. As the beach is close to the foot of the cliffs at this point, and the town lies back in a hollow among the rocks, the water must be delivered to a reservoir upon the higher part of the cliffs. This is accomplished by piercing a short tunnel into the face of the cliffs opposite the intakes, and constructing a vertical shaft to the upper surface of the hill. A pumping chamber, excavated in the chalk about the middle of the tunnel, contains the pumping machinery, which draws the pure spring-water from the intakes and forces it to the reservoir 250 feet above.

There are two sets of pumps, driven by vertical petroleum motors of the Noël type, the pumps being geared to the motor shafts, and the whole arrangement being compact and symmetrical. The pumps can be thrown out of gear while the motors are being started, and gradually engaged with the work by means of friction clutches.

From the nature of the supply the plant can only be operated for a portion of the time, the best results being obtained at about half tide. When the water is high the supply is naturally brackish, while curiously enough, at very low tide the flow of the springs almost ceases. This latter phenomenon is explained by the fact that there are probably numerous other outlets to the subterranean water supply, which are uncovered at very low tide, and that the gen-

eral relief at the lower level checks the flow of the higher outlets. In practice it is found that pure water can best be obtained by two pumping periods per day, of six hours each, the time being midway between high and low tide, although experience has shown that in stormy weather, when the tides may be higher than usual the agitation of the surface prevents the salt water from sinking into the pits, and fresh water is drawn by the pumps even when the springs are covered by several feet of sea water.

With the plant as at present arranged a supply of pure water of about 60 gallons per day per capita is readily obtained, while the installation of another pumping engine would enable this to be proportionally increased without difficulty, the flow of the springs being ample for an increase of population.

Yport has long been looked upon with favour as a seaside resort, lying as it does between Fécamp and Etretat, but until now the absence of a satisfactory water supply has prevented it from becoming popular. The present works remove entirely any objection on this score, and both as a neat solution of an engineering problem and as a municipal improvement this little installation is well worth noticing.

The Influence of Temperature upon Alloys.

In a recent issue of this magazine the exhaustive experiments made at the Royal Testing Laboratory at Charlottenburg upon the effect of heat upon the strength of copper were discussed at length.

At that time it was noted that the effect of heat upon strength was influenced to a marked degree by the presence of small quantities of other metals, and it was suggested that for locations where the material was to be exposed to heat, it was probable that certain alloys might be better adapted to the purpose than the pure metal.

This subject is discussed in a very thorough manner in a long paper by M. Georges Charpy in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, devoted especially to the very complete researches of M. Andrea Le Chatelier upon the influence of temperature upon metallic alloys, as well as upon the tests made by the author himself.

The trials were made by two methods,

using the tension test in a horizontal Mailard testing machine, and also the drop test.

In the former method the test piece was heated by immersion in a bath of oil, the connections with the heads of the machine being made with strong yokes which permitted the specimen to be immersed in the oil during the application of the stress. In the application of the drop test it was more difficult to effect the heating, as it is impracticable to apply the heat to the piece in place and when the specimen is heated before clamping it is apt to cool before the application of the test. The latter method was adopted, however, taking especial precautions to avoid loss of heat.

In the complete paper of M. Charpy the details of the tests are fully given, including chemical analyses of the alloys, and graphical diagrams of the results, and we can only give here the general conclusions which are drawn, with some comments upon the practical applications.

In general the following results have been determined by comparison of many experiments:

Pure copper diminishes in strength regularly with an increase in temperature, the rate of diminution of strength being represented by the formula:

$$R = 21 \text{ kg} - 0.025 \text{ } t$$

t , being the temperature in degrees centigrade.

Alloys of copper and tin give results which vary greatly according to the composition of the specimen. In some cases there is a rapid falling off in strength and elongation at temperatures exceeding 180° to 200°C. , as shown by the experiments of the British Admiralty and of Professor Unwin. In other cases the strength is well maintained up to 250°C. , this always being the fact with phosphor-bronze, and in some instances with bronzes in which no deoxidising material is employed.

Aluminum bronzes exhibit a peculiar behaviour, showing a sudden drop in strength between 80° and 150° , this being only 5 or 10 kilogrammes for drawn or rolled metal, but reaching a much greater amount for cast specimens.

All kinds of common brass show a rapid diminution in strength and elongation from 250° to 300°C. ; the breaking resistance at

250°C. being only about 15 per cent. of the value at ordinary temperatures.

Brasses containing 1 per cent. of aluminum show a higher resistance at elevated temperatures than bronze or rolled brass, giving a resistance of more than 20 kilogrammes per square millimetre, (28,000 lbs. per square inch), with a considerable elongation up to 260°C.

In the case of iron and steel the breaking strength diminishes for temperatures varying between 60° and 100°C. according as the metal is more or less hard, after which it increases until it attains a maximum at about 250°, then decreasing rapidly beyond 300°.

The difference in strength between 15° and 250° is at least 8 to 10 kilogrammes, whatever be the hardness. The elongation varies in the inverse direction to the resistance. The reduction in section diminishes continuously from the ordinary temperature up to 300° or 350°, while above 400° it increases very rapidly, becoming very marked at 700° and 800°.

The importance of these researches is evident when it is considered that the continual increase in steam pressures now so general is rendering it most necessary that the strength of all materials in contact with high-pressure steam should be known in connection with the temperatures at which they are used. Many parts of steam machinery which are proportioned with ample strength, based upon tests made at ordinary temperatures, are altogether insufficient when the reduction in strength by heat is considered. The researches of Le Chatelier, Charpy, Roberts-Austen, Martens, Unwin, and many others are furnishing ample material to enable such errors to be avoided, and by changes in dimensions and proper choice of materials the changed conditions may in great measure be met.

Electricity on Main-Line Railways.

THE rapidity with which electric power has been applied to the operation of tramways and of short local railways has led to many predictions as to the invasion of the domain of main-line railways, and the disappearance of the steam locomotive from active service before many years shall have elapsed. A recent issue of the *Zeitschrift*

des Vereines deutscher Ingenieure contains an exhaustive review of the present state of the problem by Herr C. P. Feldmann covering what has been done, not only on the continent, but also in the United States.

By way of effecting a proper comparison of cost in operating railways with steam or electricity, Herr Feldmann begins by examining the progress which has been made in economical transport under existing methods during the past thirty years, showing by plotted curves the manner in which the rates have been reduced, and giving an excellent opportunity of examining the advance which electric driving must make if it is to stand on an economic equality with steam in this respect. An examination of these diagrams shows that the transport of merchandise is the principal source of revenue of main-line railways, and that under existing conditions, as well as under those which will probably obtain in the approaching future, steam locomotives will continue to prove more economical than electricity.

With passenger transportation, however, the conditions are very different. By far the greater number of passengers is included in the local and short-distance runs, and the long-distance passenger traffic forms a minor portion of the business and one from which the revenue forms a secondary consideration compared with the important and profitable local business. It is for the handling of this local traffic on the branches of main-line railways that Herr Feldmann sees the important function of electric power, and in support of this view he cites the success of many installations, mostly from American practice.

There is little doubt of the fitness of electric power for this local service, but this may more justly be regarded as an extension of the shorter line tramway roads, which have developed so enormously of late, than as true main-line service. Electricity, however, has already shown itself to possess advantages for certain branches of main-line business, apart from any claims to superior economy, and among these may be noted freedom from smoke and gas, besides relief from the necessity of transporting supplies of fuel and water. The electric locomotives in the Baltimore tunnel may be cited as one instance of the

value of smokelessness, and another is seen in the report of the adoption of electric power in the prolongation of the Orleans railway in Paris; and the extension of successful practice in such partial installations to other portions of the roads is a feature which may only be dependent upon the demonstration of practical advantages.

The introduction of electric power has only been delayed by such abnormal devices as the Heilmann locomotive, which united the disadvantages of both steam and electricity; but, from the nature of things it is evident that some more effective method of hauling loads over railways should be found than that of using a portable power-house for every train, as is now the practice. The relief to the roadway by the substitution of rotary for reciprocating motors is a feature which should also be considered in making up the balance of cost, and until the entire advantages of electric-driving are fully demonstrated it will continue to be difficult to make intelligent comparisons which shall take all the controlling elements into account.

Railway Trestles in Austria.

THE use of the iron trestle bridge for railway viaducts has been mainly limited to the United States, but in a recent issue of the *Zeitschrift des Oesterr. Ingenieur und Architekten Vereines* a description is given of some examples of trestles quite on the American plan, which have been erected on the line of the Waidhofen-Gaming local railway.

The circumstances which led to the choice of this somewhat unusual construction in Austria, were the necessity of crossing two valleys at points where the widths were 300 and 350 feet, and the depths 65 and 85 feet, while in one case these conditions were combined with grades from 2.5 to 3.2 per cent., and a curve of 200 feet radius. These conditions made the use of arches or long-span trusses inexpedient, both on account of expense and constructive difficulties, and hence the very American looking trestles which are illustrated in the article were adopted.

The construction of the curved portion of the viaduct has been very well worked out, the wide spread which is given to the

central trestles insuring ample stability, notwithstanding the tendency to lateral deflection, caused by passing trains, while the details of the bracing and the arrangement of foundations give stiffness with moderate weight.

While to the railway engineer, familiar with American practice, these trestles offer little or nothing new, the fact that this simple and economical method of spanning valleys, regardless of grade or curve has found its way into Austria is but another example of the rapid international exchange of engineering ideas now everywhere so apparent.

The Action of Sea Water on Alloys.

THE use of copper and its alloys as a material for the sheathing of vessels, and in other locations where it is exposed to contact with sea water, renders it most desirable that a knowledge of the behaviour of materials of a known composition should be determined so far as corrosion is concerned. For this reason the German government has caused a number of tests to be made, and from the report of Chief Engineer Diegel, very fully abstracted in *Stahl und Eisen*, the principal results of these investigations are taken.

Since the experiments extended over a period of two years, and were conducted with great care and thoroughness, there is every reason to believe that the information thus acquired is the most complete contribution to knowledge in this direction which has yet been made.

The tests were made by suspending the specimens into the sea water from a bridge in the harbour of Keil, so that they were exposed to the action of the water in a manner similar to that which occurs in actual practice. Twelve strips were cut from a sheet of the metal to be tested, nine being suspended in the water and three being retained for comparison. At intervals of eight months three strips were taken out of the water and broken in the testing machines as was also one of the reserved pieces, and thus a comparison of the exact deterioration due to differences in location could be determined. Tests were thus made with immersions of 8, 16, and 24 months, and in addition some trials were made after immersions of 16 and 32 months.

As the atmosphere is known to have an injurious effect upon alloys containing much zinc, specimens of such alloys were also exposed to free contact with the air, in order that the loss of strength from this cause might be determined.

The trials were limited to such alloys as are actually used in shipbuilding, or which are likely to be considered for such work, there being the following five groups: copper alloys rich in zinc; bronzes containing little zinc; pure tin-bronzes; pure aluminum bronze and iron aluminum-bronzes.

The results of these tests are given at length in the original report, with diagrams showing the relations of the various alloys, but for this the original paper must be consulted. We can give here, however, the general conclusions which were drawn from the behaviour of the different materials, and some comments on their application. Considering first the behaviour of the specimens in air, it was found that the iron-bronze alloys resisted atmospheric influence remarkably well, there being practically no deterioration in strength during two years; those alloys containing much zinc did not behave so well, but no tests were made as to the resistance of the iron-zinc bronzes to the action of the air.

When immersed in sea water in contact with iron, the iron, tin, and aluminum bronzes all retained their strength very well. After exposure to the water for 2 to 2½ years there was no marked difference in appearance, nor was there any reduction in weight, while tension tests showed no reduction in strength. Iron bronzes in contact with tin bronze showed a material loss after exposure to sea water, the zinc dissolving out, but this action was less rapid with the aluminum bronzes. A specimen of iron bronze in contact with tin bronze

after two years' immersion in sea water showed a loss of $\frac{2}{3}$ of its original strength and 4-5 of its extensibility, and the structure was partially destroyed by the eating away of the zinc. Cast and wrought bronzes appeared to be equally affected. A wrought plate of iron bronze in contact with a cast plate of the same material was rapidly affected, and in two years its strength was diminished by about 60 per cent. An iron bronze and a phosphor bronze, attached to a piece of oak, showed a slow corrosion of the iron bronze, 20 per cent. of its strength being lost in 23 months.

The important conclusion which was drawn from the experiments was the influence of the metal to which the sheathing is attached. Thus, for instance, tin and iron bronzes both give good results in contact with iron, but are injuriously affected in contact with each other, while the iron itself is least corroded when sheathed with an iron bronze.

The principle which governs the corrosive action between different metals is that of their relative position in the electrical scale, and the same considerations which govern the choice of metals for galvanic action enter into the question of injurious corrosion. Pure aluminum bronze, for example, resists the action of sea water remarkably well when in contact with metals which are electro-negative towards it, while contact with electro-positive metals causes its rapid destruction. It is therefore most desirable to place those metals in contact which are close to each other in the electrical scale, and any statement as to the resistance of an alloy or sheathing metal to corrosion is misleading unless it includes a description of the material with which it is said to be used.

REVIEW OF THE AMERICAN PRESS

Electricity on Board Ship.

THE important subject of the general use of electric power on shipboard, with especial reference to the electrical driving of auxiliary machinery was presented recently in a paper before the American Institute of Electrical Engineers by Mr. S. Dana Greene, and elicited an animated discussion, during which a number of interesting points were brought out.

The advantages of centralizing the generation of electrical power in one plant and its distribution by suitable means to individual users have long been realized in many cities, but little has been done in this direction on vessels, both because of the well known dislike of seafaring men to innovations, and also because of the difficult conditions involved in installing apparatus to be exposed to salt air, moisture and heat. The introduction of electric lighting, however, has prepared the way for the more general use of electricity, partially overcoming the prejudices of the seamen, and also furnishing the electricians with valuable experience in contending with the peculiar conditions of the service.

In certain directions everyone now admits the suitability of electric driving for the innumerable power-requirements on shipboard, other than the main engines. No other method admits of a safe, cool and flexible system of distribution. Electric motors can be placed anywhere, may be started from any desired point, emit no exhaust discharges, and as now built, are entirely reliable. It will undoubtedly be necessary to enclose and protect the motors against weather and water, but the difficulties attending such protection are no greater than have been successfully overcome in the case of street car motors. The experience on board the Brooklyn during the war with Spain showed the superiority of electric motors over steam in the one point of reliability alone, two of the turrets having been fitted with steam motors and two operated by electric motors. There is therefore no question among well-informed en-

gineers as to the practicability of making electric power entirely reliable for all auxiliary work on shipboard.

The next question is the advantage which may be obtained by the change. In the first place, a great gain in economy may be expected by the substitution of a central power plant for the innumerable small steam cylinders now used on every steam vessel. The trials of the Minneapolis, the Terrible, the Argonaut, and other vessels, have shown that the auxiliary steam machinery requires from twenty-five to forty per cent. of the total amount of steam generated by the boilers, the loss being especially great when the vessel is cruising under part power, and when economy is especially desired.

Mr. Greene shows very conclusively that by the use of a central power plant and electric distribution and driving for the auxiliaries, nearly seventy per cent. of the steam now required can be saved, and although the steam consumption could undoubtedly be reduced very materially by compounding, and by the introduction of other improvements, the cost would still be 100 per cent. in excess of that required for electric driving.

"The applications of electric driving to the various ship auxiliaries must be carefully studied in each case. The problems involved, however, are not more difficult than many special applications on shore, nor is there anything about them which a competent electrical engineer, with a proper knowledge of sea conditions, is unable to solve. The first cost will undoubtedly be greater than with steam driving, but the saving in operative expense, if capitalized, will much more than offset this difference in first cost."

The question of obtaining and retaining in the naval service men competent to operate and care for electric machinery, received some discussion in connection with Mr. Greene's paper, but there seems to be no good reason why this should not be accomplished in the navy with at least the same

measure of success as has been readily attained in stationary power house practice and in tramway service. In nearly every case the electric motors are simpler, and require less care than do steam auxiliaries, and the ease with which very ordinary labor manages electric cars under most trying conditions would seem to warrant freedom from anxiety on that score.

The question of the healthfulness of a vessel which is free from the innumerable steam pipes and excessive heating is also a matter for consideration. The recent experiences in the tropics have demonstrated that vessels equipped in northern latitudes contained many devices and arrangements which would have been made very differently had the builders been familiar with tropical conditions, while the ease with which ventilating motors can be placed wherever necessary when electric power is available, is certainly a consideration.

The suggestion has been made that two vessels, otherwise identical shall be fitted out, one with steam auxiliaries, and the other with an electrical equipment, and exhaustive comparative trials made; and many men feel that the results would be greatly in favor of the electric driving.

The Production of Gold.

AN interesting paper by Mr. A. E. Outerbridge, in the *Popular Science Monthly*, calls attention to the great increase in the gold production of the world in 1898 over that of 1897, and as much of this increase is undoubtedly due to the application of engineering and scientific methods to mining operations, some of the points treated are of technical importance.

"The output of gold in the United States in 1898 was more than twice that of 1890; and the production of gold in the world in 1898, at the lowest estimate, was more than twice the estimated production in 1890."

While a portion of this great increase has come from the discovery of new workings, by far the greater portion of the gain in the past few years has been due to the application of methods for dealing with ores of such low grade that they were formerly unprofitable for working. The introduction of the cyanide process has not only enabled "tailings" formerly thrown aside as unworkable, to be treated at a

profit, but has rendered possible the treatment of very low grade ores, in some cases such as contain less than one-quarter of an ounce of gold distributed through a ton of ore. In the United States there are now about twenty-five cyanide plants, while in South Africa, where the process has received its greatest development, there are more than forty plants. The success of these plants has caused attention to be directed to the possibility of considering gold-getting in the light of a manufacturing business, involving not merely a mine or source of ore, but also a large manufacturing and engineering plant, the permanent investment of a large amount of capital, and all the organization of a great industrial enterprise. In many cases such a business includes the employment of much machinery, including appliances for dredging the river beds or conveying large supplies of water over long distances, and from being the vague lottery of past years the conduct of gold mining is rapidly becoming a scientifically conducted business operation, not greatly different from the mining of coal, iron or copper.

This view of the subject relates principally to the business of extracting gold from low-grade ores by scientific methods on the large scale, where the precious metal is evenly distributed throughout the matrix of gangue, and since the element of chance is practically eliminated it is a legitimate field for the investment of capital, altogether different from the lottery of digging for nuggets.

The extent to which scientific and engineering methods will develop the rate of gold production cannot be foreseen, but there is no lack of low-grade ore upon which processes can be employed. Indeed from this point of view there are many things which come under the title of ore, which can never be expected to offer a commercial profit. Mr. Outerbridge refers somewhat humorously to the fact that the clay underlying the city of Philadelphia has been demonstrated to contain more gold than has been brought from California and Australia, and we have all heard of late of the importance of the waters of the ocean as gold ore, but apart from such chemical curiosities as the detection of a trace of the precious metal in some com-

mon material, there are undoubtedly many ores, now too low in grade to be considered as commercially practical for working, which may become fairly profitable when treated on a very large scale by methods yet to be developed. Gold hunting is certainly in a fair way to be wholly removed from the sphere of adventure and chance, and entirely included in the domain of engineering and scientific industry.

Engines for Superheated Steam.

IN the course of a recent discussion before the American Institute of Electrical Engineers, Professor Elihu Thomson described a form of single-acting steam engine which is remarkably well adapted to be operated by steam of high temperature, and with which he said that he had obtained most excellent results. This engine, which Professor Thomson states is very similar to that which M. Serpollet is using in his steam motor vehicles in Paris, consists of a single vertical cylinder, open at the bottom, and fitted with a plunger piston to which the connecting rod is directly attached. Openings are provided to the atmosphere through the wall of the cylinder in such position as to be uncovered when the piston arrives at the end of the stroke, while steam is admitted at the beginning of the stroke by a poppet-valve at the top. The action is as simple as the construction. High-pressure superheated steam is admitted for a short portion of the stroke and then cut off, and when the piston reaches the end of the stroke the steam exhausts through the openings which are uncovered by the piston. The return stroke is produced by the momentum of the fly-wheel, and the steam which is entrapped in the cylinder after the exhaust openings are closed, is compressed in the clearance space, which is so proportioned as to give the desired degree of compression.

Professor Thomson explains the high economy attained by the engine of this type which he has constructed, by the following considerations. Instead of reversing the motion of the steam during the exhaust, and throwing it back over the heated surfaces, the steam always flows in a forward direction. The incoming steam comes in contact with highly heated

surfaces, thus reducing cylinder condensation to a minimum while any water of condensation, instead of being re-evaporated, is thrown out through the exhaust opening at the end of the stroke. The cylinder full of exhaust steam is compressed on the return stroke nearly or quite up to the initial pressure, and is thus superheated again to meet the incoming live steam, and so heat losses through the cylinder walls are reduced to a minimum. The whole action is somewhat similar to the gas engine, except that it uses a double, instead of a quadruple cycle.

A small four-cylinder engine of this form, with cylinders $2\frac{1}{2}$ inches diameter, 3 inches stroke, using highly superheated steam at 160 to 200 pounds pressure, has, according to Professor Thomson, given the result of $20\frac{1}{2}$ pounds of steam per horse-power-hour, certainly a remarkable economy for so small an engine.

It is most interesting to note that this engine is an almost exact reproduction of the famous engine built by Jacob Perkins early in the present century, and which attracted so much attention, both in London, where it was operated publicly, and also in the United States, of which Mr. Perkins was a native. The Perkins engine used steam at 800 pounds pressure, admitted it by a poppet-valve actuated by a cam, giving a prompt cut-off, and then exhausted through openings uncovered by the piston at the end of the stroke in a manner identical with the engine described by Professor Thomson. The steam remaining in the cylinder was compressed in the same manner, and there appears to be an absolute identity between the two machines.

The Perkins engine is very fully described and illustrated in Galloway's *History of the Steam Engine*, published in 1830, and also in the *Journal of the Franklin Institute* for 1827, and both in his ideas of the generation and the use of steam. Perkins is seen to have been far ahead of his time. The true reason for the failure of his engine to attain commercial success, was the same which has delayed generally the introduction of superheated steam, i. e., the mechanical difficulties connected with lubrication and packing at such high temperatures. A comparison of Perkins's

work with that of his contemporaries shows the excellent knowledge of design and construction which he possessed, while his theoretical views were quite in accordance with modern practice.

We have shown this entire anticipation, not for the purpose of detracting in the slightest degree from the efforts of Professor Thomson, for, on the contrary, we believe his experiments will go far to renew attention in this excellent form of engine, but rather to call attention to the remarkable manner in which Perkins grasped the true principles upon which steam economy could best be effected. With the improvements and advances which have been made in engine construction, and with the application of modern metallic packing and lubricants there seems to be now no good reason why engines of this type, using high pressure superheated steam, may not give the high results in commercial practice which Perkins predicted for them more than seventy years ago.

The Care of Drawings.

In the modern machine works, the drawing office forms a very important feature, both in the results which it produces, and in the proportion of expense which it causes, and every detail which increases efficiency and diminishes expense is worthy of careful thought. Various methods of classifying and indexing drawings have been adopted, and doubtless there are numerous good ones which differ widely from each other, and unfortunately there are yet machine shops which have no complete or systematic method of doing this important work, much being trusted to memory, and not made a matter of record.

A recent issue of the *American Machinist* describes the practice of two important establishments in filing and indexing drawings, noting that the two works differ widely in the character of their product, the one being devoted to moderate sized machine tools, produced upon a manufacturing basis, and the other undertaking the largest constructions, with few or no repetitions. The fundamental peculiarity in both of these establishments lies in the fact that the drawings are filed by size, and not by title. All drawings of a size are filed together, regardless of the machine to which

they belong, and the location of the drawings for any machine is determined by reference to the index. Since the blue print system is practically in universal use, the drawings or tracings need not be used for any purpose except printing, or as subjects for subsequent tracings, and the full set of blue prints made for construction purposes from an assembled record of the entire machine and render the collective filing of the originals unnecessary. The index may be either in a book or on cards, although the card system is as superior for this purpose as it has been found in library and other work. If a drawing is removed from its place for any purpose, a special index card, bearing the number and title of the drawing, as well as the place and person to which it has been sent, can be put in the index at the proper place. The whereabouts of every drawing can thus be indicated at all times, the special card being removed and destroyed when the drawing to which it refers is returned.

It is the practice of one of the establishments to bunch together and store in a separate fire-proof vault, the full set of blue prints used in the construction of any machine, thus insuring against the possibility of loss in case of fire, and also preserving a record of the actual construction of a given machine or lot of machines, regardless of any subsequent changes which may be made in the standard drawings. This question of protection of drawings against fire is always an important one, and is met in various ways in different establishments. Where general elevation tracings of the entire machine are made, it is a simple matter to take photographs of the tracings on a reduced scale, a double-elephant sheet being readily legible when reduced to 8 by 10, or even 6½ by 8½, and such negatives, made on films can be stored in a very small space in a fire-proof vault. In case of a destruction of the originals by fire, enlargements from these are readily made, and the economy of storage is evident.

The filing and recording of sketches is a matter which is not always given the attention which it deserves. The too common practice of making sketches on loose sheets or scraps of paper, should not be permitted, each draftsman being provided with a book in which all sketches and com-

putations should be made, these being indexed in the same manner as a letter copy-ing book. Apart from the importance of preserving all such preliminary work for possible future reference, the mere fact that it may be subject to examination will go far toward producing neat and accurate work.

While no general system of filing and indexing the products of the drawing room can be devised which shall be applicable to all establishments, the practice of leading shops will often furnish valuable ideas to others, and every shop, however small, should have some systematic method of caring for important things.

Electric Power in the United States.

THE development of natural sources of power and their transmission and utilization by means of electricity has been discussed so often in these columns and elsewhere that no enlargement upon the importance of the matter is necessary at the present late date. It is, however, desirable that the progress of this important branch of engineering industry should be recorded from time to time, especially as its development includes details of interest to the civil, mechanical, and electrical engineer, besides being of vital importance to the managers of works, both from the technical and commercial side.

A recent issue of *Power* contains a very full account of many of the power and transmission plants now in actual operation in the United States, together with some examples of electric power applications, and from this article some interesting facts as to the present status of the matter may be obtained.

As typical examples of modern practice three power-generating plants are described: The one at Minneapolis, Minn., and the two plants in Utah, one in the Ogden Canon, and the other on Big Cottonwood Creek.

"The plant at Minneapolis is of rather special interest in that it has displaced three steam stations formerly used as power houses by the Twin Cities Rapid Transit Co., whose street-railway systems extend throughout and between St. Paul and Minneapolis. All the power for these lines is now generated at one station, situated

on the lower St. Anthony Falls, and transmitted to various points of distribution in the railway network."

Here 10,000 horse-power is generated by direct connected turbines, there being 8,000 horse-power produced as alternating three-phase current for transmission to St. Paul, ten miles away; and 2,000 horse-power, as continuous current for near-by service, the alternating current generated at a pressure of 3,450 volts, is reduced by step-down transformers at Minneapolis to 387 volts, and then converted into a direct current of 600 volts for delivery to the railway feeders. Although ten 1,000 horse-power steam engines were to be provided as an emergency equipment, there has as yet been no occasion to put any portion of it into service, the hydraulic power plant having worked so successfully since the start that no steps have been taken towards adding to the steam plant.

The Ogden Canon plant differs from that at Minneapolis, in that it is an example of the transmission of the entire output of the generating station to a great distance. By constructing a dam across the head of the canon, a reservoir of about 2,000 acres was formed, from which a pipe-line, 6 feet in diameter is conducted to the power house, six miles distant, a head of 450 feet being obtained. This is utilized by five impulse wheels connected directly to three-phase generators of 1,000 horse-power each, the generator voltage being 2,300, which is raised by step-up transformers to 16,100 volts for the transmission circuit. The current is then transmitted entire to a distributing station in Salt Lake City, thirty-eight miles distant and utilized for various purposes by well-known methods.

The plant on the Big Cottonwood Creek offers an excellent example of a modern plant, midway between those previously mentioned, both in origin and in application. Here, 3,000 horse-power is generated by a dam, reservoir, main, and impulse wheels, the diameter of the pipe-line being 50 inches, and the head of water 375 feet. This plant is situated about fourteen miles from Salt Lake City, and the three-phase current, raised to a pressure of 10,500 volts, is utilized at various points along the transmission route, as well as at the terminus. Thus a large flour mill, half-way between

the station and the city, is driven by the current, and a small town supplied with light; while several large smelters are supplied with both light and power, and are operated night and day throughout the entire year.

These three examples are typical of what has been accomplished in a number of other places, and yet the work of exploitation of the natural hydraulic power resources of the United States, not to mention other portions of the world, is but begun. It is becoming evident that for many purposes the possession of coal beds is no longer to be the cause of the command of industries which require power, and the very fact that those regions in which water-power is the most abundant are in many cases the ones in which coal is least plentiful and most costly, will lead to a re-distribution of the location of many industries in the immediate future.

Concerning the applications of electric power but little need be said, for they are becoming so familiar to everyone as to be well-known everywhere. Apart from questions of cost, the advantages of convenience, cleanliness, freedom from smoke, gas or heat, all enter into the desirability of this form of motive power. With the general introduction of cheap and convenient electric distribution of power a formidable rival to the factory system must eventually spring up, and it is already time for thoughtful manufacturers who are using customary methods of driving to compute the probable life of their plants by the progress of their competitors, rather than by the old-time methods of wear and tear.

Permanent Way Construction.

SEVERAL months ago there was published in *Engineering News*, a description of an improved method of construction for permanent way, consisting in the main of the use of longitudinal girders of concrete under the rails, instead of the usual cross ties, the rails being tied at intervals by suitable metallic distance pieces. This paper was reviewed at length in these columns—in the February issue of the current year, and now the subject is again brought forward in view of the publication, with editorial comments, of correspondence elicited by the original contribution.

There is little doubt that the present system of constructing permanent way by imbedding cross-ties in a mass of broken stone as a support for the rails, is open to improvement, but apparently all the correspondents are not of the same mind about the best method for improving the work. Such an able engineer as Mr. Gustav Lindenthal expresses himself as in favor of a longitudinal metallic support, as do other engineers; while various forms of clips, bolts and fastenings are suggested. The interesting feature about the whole discussion lies in the fact that no one appears to have a good word to say for the present system of cross-ties and loose ballast.

The whole subject of road-bed construction forms an interesting chapter in engineering evolution. The early roads were constructed with longitudinal stringers of wood, or with stone blocks, and those who are familiar with the schemes of Mr. W. B. Adams, nearly fifty years ago, will recognize how nearly some of the present girder rails approach his "suspended girder." The breakages due to the too great rigidity of foundations had their true origin, not so much in the foundations as in the rails, and with the present deep and stiff rails, and the still heavier and more rigid ones which have been proposed, it is a question whether a more rigid substructure may not be desirable.

So far as the use of wooden sleepers is concerned, there is little doubt that they can be replaced to advantage by metallic cross-ties. The experiments of the Liège-Limburg Railway, extending over a period of eighteen years, described very fully in the Bulletin of the International Railway Association by M. Renson, and reviewed at length in the issue of this magazine of December, 1898, showed the superiority of well-designed sleepers of steel. The form evolved by M. Post from the successive experiences with less satisfactory designs, seems to be adapted for the construction of a very successful permanent way, and, when used with the best modern heavy rail-sections, should give a degree of stiffness capable of serving even under the heavy train-loads and high speeds now common. It must not be forgotten that there is such a thing as making a road-bed too permanent, and that few modern constructions

are permitted to remain unchanged until worn out. If strength and stability under working conditions are fully attained, it is sufficient if the life of a construction is long enough to endure its probable period of usefulness, and modern experiences in nearly every line of engineering are demonstrating that many other things besides durability enter into the commercially valuable life of a device.

In regard to the use of stone ballast, it has yet to be demonstrated that it has any superior for latitudes in which much frost is to be met. Any substructure which depends for its permanence upon the sealing it against the penetration of water from above, is of doubtful value in northern climates, while loose ballast well drained has been found best adapted to meet this most insidious enemy.

Methods of Prospecting for Gold.

IN investigating placer deposits for gold the usual method of prospecting has been the slow and expensive one of sinking shafts. The cost of thoroughly prospecting a piece of ground by this method is so great that few owners have felt able to investigate the property fully before beginning dredging, and in consequence of this fact, many dredging operations have proved failures simply because the really valuable portions of the ground were not worked.

In a paper by Mr. R. H. Postlethwaite, published in the *Mining and Scientific Press* a method of prospecting by means of the much cheaper operation of drilling is described, and from the close comparative results which have been obtained when both drilling and shaft sinking have been adopted, it appears as if the former method could be made a very reliable one.

The operation of drilling is a comparatively simple one, the principal feature being the care which is necessary in order to avoid obtaining untrustworthy results. By the use of a form of traction engine, provided with walking-beam and mast, a heavily weighted steel bit is lifted and dropped upon the point to be drilled, the bit being turned by hand for every stroke, and thus drilling a round hole about six inches in diameter. By allowing a small quantity of water to run in the hole the cuttings are churned into a thin mud, and this is re-

moved by a so-called sand pump, consisting of a barrel with a valve at the bottom. This is lowered into the hole from time to time, the drill being removed, and thus the cut material is taken out, and can be panned at once. The drill is followed by an iron pipe, forming a lining for the hole, otherwise a deceptive estimate might occur through the caving in of some of the material on the sides of the hole. The whole operation is so very much cheaper than the sinking of shafts that it makes it possible to make a critical examination of a tract to an extent that will permit the subsequent operation of dredging to be intelligently conducted.

It is the application of just such mechanical methods to mining operations which is taking the business out of the old hit-or-miss category, and placing it where it belongs, with other business and engineering work, and there is every reason to believe, as has been indicated elsewhere in this issue, that the increase in the output of gold will largely depend upon the introduction of engineering methods.

Formulas for Train Resistance.

THE publication of the formulæ for train resistance by Mr. John Lundie, noticed in these columns in the March issue, has resulted in much discussion in various quarters, and the whole subject is treated in a very thorough manner in the *Street Railway Journal*, by Mr. J. B. Blood, forming an excellent review of the work done by himself and others.

"Train resistance has been a subject which has figured largely in mechanical engineering. A great many men in the United States and in Europe have made attempts to formulate it in some convenient manner. Some of these men have been eminent technically, while others have been interested in the subject more from an operating or practical standpoint. Most have desired to make an empirical form of an equation which would best express the results obtained by experiment, irrespective of the different factors which go to make up these results; few appreciated that train resistance was a combination of factors, and that if any one factor was pre-eminent above the average the whole empirical formula would fall. Probably most of the

people who have worked upon this subject appreciated the different factors which go to make up resistance as such, but judging from their formulas they did not appreciate the function of these factors and their relative amounts, and also that they were liable to occur in different proportions under different conditions."

Mr. Blood reviewed at length the different formulas which have been proposed, from the one by D. K. Clark in 1854, down to the present time, and examined the character of the experiments and data on which they were based. Plotting the results obtained from these various formulas, after having reduced them to comparable form, he showed how variations appeared as the conditions upon which they were based were departed from.

It appears that at low speeds the plotted curve departs so little from a straight line that it was permissible to represent the results by an equation containing only the first power of the speed, while at higher speeds this does not hold good.

There are three main factors which go to make up train resistance: journal resistance, practically constant at all speeds; friction between rails and wheels, varying approximately with the speed; and wind resistance, independent of the weight of the train and varying as a fractional power

of the speed. Grouping these as terms of a formula, and supplying coefficients determined from all available experiments, Mr. Blood gives a formula which appears to be rational, and to agree well with the data upon which it is based. With our present information, the coefficients must be considered as tentative, and subject to revision as further experiments furnish additional data, but there is no reason to change the character of the formula on this account.

Mr. Blood shows that the method of measuring resistance by coasting, as adopted by Mr. Lundie, is not new, but was used before the later dynamometric tests. He considers the method by pull, far more satisfactory, as approaching more closely the conditions of practice, but also thinks that calculations from the power exerted by electric motors offer the best chance for accuracy.

With the accurate methods now in use for measuring forces and other physical quantities there seems to be every reason why very accurate data should be obtained for the purpose of settling this important problem, and the concerted action of a number of the leading railway companies, as well as of the electric tramways, should make the accumulation of ample data a comparatively simple task.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

We hold ourselves ready to supply—usually by return of post—the full text of every article indexed, *in the original language*; and our charge in each case is regulated by the cost of a single copy of the journal in which the article is published. The price of each article is indicated by the letter following the number. When no letter appears, the price of the article is 20c. The letter A, B, or C denotes a price of 40 cts.; D, of 60 cts.; E, of 80 cts.; F, of \$1.00; G, of \$1.20; and H, of \$1.60. In ordering, care should be taken to *give the number* of the article desired, not the title alone.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, *etc.* Other abbreviations used in the Index are: *Ill*=Illustrated; *W*=Words; *Anon*=Anonymous.

American Architect. <i>w</i> . Boston, U. S. A.	Canadian Architect. <i>m</i> . Toronto.
American Electrician. <i>m</i> . New York.	Canadian Electrical News. <i>m</i> . Toronto.
Am. Engineer and Railroad Journal. <i>m</i> . New York.	Canadian Engineer. <i>m</i> . Montreal.
American Gas Light Journal. <i>w</i> . New York.	Canadian Mining Review. <i>m</i> . Ottawa.
American Geologist. <i>m</i> . Minneapolis, U. S. A.	Chem.Met.Soc.of S. Africa. <i>m</i> . Johannesburg.
American Journal of Science. <i>m</i> . New Haven, Conn.	Colliery Guardian. <i>w</i> . London.
American Machinist. <i>w</i> . New York.	Compressed Air. <i>m</i> . New York.
Am. Manufacturer and Iron World. <i>w</i> . Pittsburg.	Comptes Rendus de l'Acad. des Sciences. <i>w</i> . Paris.
American Shipbuilder. <i>w</i> . New York.	Consular Reports. <i>m</i> . Washington.
Am. Soc. of Irrigation Engineers. <i>qr</i> . Denver	Contemporary Review. <i>m</i> . London.
Annales des Ponts et Chaussées. <i>m</i> . Paris.	Deutsche Bauzeitung. <i>b-w</i> . Berlin.
Architect. <i>w</i> . London.	Dingler's Polytechnisches Journal. <i>w</i> . Stuttgart.
Architectural Record. <i>q</i> . New York.	Domestic Engineering. <i>m</i> . Chicago.
Architectural Review. <i>s-q</i> . Boston, U. S. A.	Eclairage Electrique. <i>w</i> . Paris.
Architecture and Building. <i>w</i> . New York.	Electrical Engineer. <i>w</i> . London.
Architektonische Rundschau. <i>m</i> . Stuttgart.	Electrical Engineering. <i>m</i> . Chicago, Ill.
Australian Mining Standard. <i>w</i> . Sydney.	Electrical Review. <i>w</i> . London.
Automotor and Horseless Vehicle Jour. <i>m</i> . London.	Electrical Review. <i>w</i> . New York.
Berg-und Hüttenmännische Zeitung. <i>w</i> . Berlin.	Electrical World. <i>w</i> . New York.
Brick Builder. <i>m</i> . Boston, Mass.	Electrician. <i>w</i> . London.
British Architect. <i>w</i> . London.	Electricien. <i>w</i> . Paris.
Builder. <i>w</i> . London.	Electricity. <i>w</i> . London.
Bulletin Am. Iron and Steel Asso. <i>w</i> . Phila.	Electricity. <i>w</i> . New York.
Bulletin de la Société d'Encouragement. <i>m</i> . Paris.	Elektrochemische Rundschau. <i>b-m</i> . Frankfurt.
Bulletin of Dept. of Labor. <i>b-m</i> . Washington.	Elektrochemische Zeitschrift. <i>m</i> . Berlin.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.	Elektrotechnisches Echo. <i>w</i> . Magdeburg.
Bull. Int. Railway Congress. <i>m</i> . Brussels.	Electrotechniker. <i>b-m</i> . Vienna.
California Architect. <i>m</i> . San Francisco.	Elektrotechnischer Anzeiger. <i>s-w</i> . Berlin.

- Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricità, *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, U.S.A.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s-an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubbl. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Heating and Ventilating. *m.* New York.
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Master Steam Fitter. *m.* Chicago.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U.S.A.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *qr.* Phila.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Públicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, U. S. A.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* Zürich.
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, U. S. A.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* Chicago, Ill.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Western Railway Club Pro. Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, U. S. A.
 Year Book of Soc. of Engs. Univ. of Minn.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING.

CONSTRUCTION.

Earthquakes.

Earthquakes and Building Construction. Review of a work by John Milne, which contains chapters on buildings and materials in earthquake countries which are of much value. 2500 w. Builder—March 4, 1899. No. 26517 A.

Lescasse on Building in Regard to Earthquakes. Part first gives a description of the Japanese building system, with criticisms. 2800 w. Ind Engng—Jan. 28, 1899. Serial. 1st part. No. 26338 D.

Fireproofing.

Fireproof Stable Construction. Illustrated description of a large stable in Chicago, which has an iron framework and an unusual form of concrete floor. 1000 w. Eng Rec—March 11, 1899. No. 26481.

London Methods of Fireproof Floor-ing. F. R. Darrow. Brief illustrated descriptions of the varied forms devised, with discussion of the construction in general. 1800 w. Brick—March 1, 1899. No. 26411.

Recent Improvements in Fire-Proof Construction at Chicago. Peter B. Wight. Illustrates and describes the Ayer Building. 800 w. Br Build—Feb., 1899. No. 26236 C.

Some Notes on the Preserving and Fireproofing of Timber and Timber Substitutes. Sherard Cowper Coles. On the various processes and the degree of success; the effect of the chemicals on the durability and strength of the wood, etc. 1500 w. Engng—Feb. 24, 1899. No. 26371 A.

Foundations.

Stresses in Steel Foundations. Samuel B. Durand. An investigation of the principles governing the design of concrete steel building foundations. 3200 w. Eng Rec—March 11, 1899. Serial. 1st part. No. 26480.

Paris Exposition.

The Paris Exhibition of 1900. General description of plan, the buildings and means of conveying material, the Alexander Bridge, etc. Ill. 2800 w. Engr, Lond—Feb. 17, 1899. Serial. 1st part. No. 26214 A.

Plastering.

Plastering, Plain and Ornamental. W. J. Hynes. Presented before the Ontario Assn. of Architects. Reviews the materials, their use and application. Discussion. 5700 w. Can Arch—Feb., 1899. No. 26276 C.

Reinforced Concrete.

The Hennebique System of Construction. (Die Bauweise Hennebique.) Prof.

W. Ritter. A full discussion of this simple and effective method of reinforcing concrete with rod and strap iron; showing numerous applications, and the method of computing proportions. Three articles. 6000 w. Schweizerische Bauzeitung—Feb. 4, 11, 18, 1899. No. 26748 each B.

The Mining and Metallurgical Building at the Exposition of 1900. (Le Palais des Mines et de la Métallurgie à l'Exposition.) Especially illustrating the use of expanded metal in connection with reinforced concrete, on some of the buildings of the Paris Exposition. 1000 w. Revue Technique—March 10, 1899. No. 26715 D.

See Civil Engineering, Bridges.

Stables.

The Acker, Merrall and Condit Stables, New York. Illustrates and describes two large stables for a firm in the wholesale and retail grocery business. 4500 w. Eng Rec—March 18, 1899. No. 26578.

Terra-Cotta.

Terra-Cotta. M. J. Hynes. Read before the Ontario Assn. of Architects. The utility and beauty of the material and its possibilities. Also discussion. 5000 w. Can Arch—Feb., 1899. No. 26277 C.

HEATING AND VENTILATION.

Centralized Plant.

The Centralized Heating and Power Plant of the Indiana University, Bloomington, Ind. J. D. Hoffman. Illustrated description of the installation of a Webster low-pressure or vacuum system. 800 w. Heat & Ven—March, 1899. No. 26648.

Factories.

Carbon Dioxide. Percy Bean. Considers its relation to the humidifying and ventilation of weaving sheds. 2800 w. Bos Jour of Com—March 25, 1899. No. 26681.

Fans.

Investigations of a Blowing Fan. R. C. Carpenter. Read before the Am. Soc. of Heat and Ven. Engs. Reprinted from the Jan. issue, with additions by the author. A résumé of experiments conducted to determine the general laws applying to centrifugal blowers of the class represented by the experimental fan. 5500 w. Heat & Ven—Feb., 1899. No. 26268.

Literature Relating to Blowing Fans. R. C. Carpenter. Prepared for the Am. Soc. of Heat and Ven. Engs. A compilation of titles of various papers which have been published. 2000 w. Heat & Ven—Feb., 1899. No. 26269.

Some Experiments with Centrifugal Fans. William S. Monroe. Results of experiments made to test the ventilating

system of the Chicago Public Library. 2500 w. Dom Engng—March, 1899. No. 26636 C.

Special Regulation of Motor Driven Fans and Blowers. Alton D. Adams. Considers methods of speed regulation and their effect on the efficiency. 1000 w. Heat & Ven—March, 1899. No. 26649.

Greenhouses.

Heating Horticultural Glasshouses. Frederick Dye. Illustrates and describes methods in use in England. 1700 w. Heat & Ven—March, 1899. No. 26650.

Post-Offices.

Ventilation and Heating of Post-office, Amsterdam, Holland. Illustrated description of the heating of a new Dutch public building by direct hot-blast, except during the coldest weather, when direct steam radiation is used. 900 w. Eng Rec—March 11, 1899. No. 26482.

Report.

Proposed Changes in the Hall of the House of Representatives. A review of the official reports on ventilation and heating of the hall. 1800 w. Eng Rec—March 25, 1899. No. 26677.

School.

Some Engineering Features of a Boston School. Illustrated description of the plant in the Mayhew High School, which is noteworthy for the method of spraying water into the heated air. 1800 w. Eng Rec—March 25, 1899. No. 26676.

PLUMBING AND GASFITTING.

Gas Fitting.

Good Gas Fitting. Act and regulations issued by the Boston Board of Health. 1400 w. Dom Engng—March, 1899. No. 26635 C.

Public Baths.

Public Baths. A. Saxon Snell. Read before the London Archt. Assn. A detailed description of the various parts of the building, with brief survey of the gen-

eral plan. Discussion. 11000 w. Builder—March 11, 1899. No. 26612 A.

Public Baths and Gymnasias in Boston. Some facts given by Hon. Josiah Quincy in an address before the People's Inst., New York. 900 w. Eng News—March 16, 1899. No. 26556.

Public Baths and Wash-Houses. A Hessel Tiltman. Views of a writer who has had many years' experience in the planning, erection and administration of such establishments. Ill. 14500 w. Jour Roy Inst of Brit Arch'ts—Feb. 11, 1899. No. 26539 F.

See Municipal Engineering, Miscellany.

MISCELLANY.

Acoustics.

Acoustics. W. C. Sabine. Discusses the acoustical problem of an auditorium, its various phases, and gives suggestions for the solution. 3900 w. Pro of Am Inst of Arch'ts—1898. No. 26486 H.

Notes on Acoustics in Architecture. Adolf Cluss. Reviews results obtained by scientists and architects, and the established laws and axioms of sound, etc. 4500 w. Pro of Am Inst of Arch'ts—1898. No. 26487 H.

Architects and Engineers.

General Practice in Regard to the Employment of Electrical, Heating and Sanitary Engineers. Notes the great changes in architecture during the last fifty years, and discusses the relation of engineering and the way to secure the best results in erecting buildings requiring an engineer as well as an architect. 8000 w. Pro of Am Inst of Arch'ts—1898. No. 26488 H.

Iron Protection.

See Civil Engineering, Miscellany.

Terra-Cotta.

Terra-Cotta. Roger Smith. An interesting review of the use of terra-cotta both for purposes of ornament and building, with information concerning its manufacture, quality, etc. 7000 w. Builder—March 4, 1899. No. 26518 A.

CIVIL ENGINEERING

BRIDGES.

Aqueduct.

The Briare Aqueduct Bridge over the Loire. (Le Pont-Canal de Briare sur la Loire.) A very complete description of this important steel-tank canal-aqueduct bridge, with map, profiles and other illustrations. 3000 w. 1 plate. Génie Civil—March 11, 1899. No. 26706 D.

Arch.

The Elastic Arch. (Sur la Voûte Elastique.) Georges Poisson. A mathematical discussion of a particular case of the

hydrostatic arch, considered in the light of the elastic theory. 1200 w. Comptes Rendus—Feb. 13, 1899. No. 26744 D.

The Merits and Permanency of the Masonry Arch Bridge. Albert W. Buel. With many handsome illustrations of masonry arches of various periods and countries, including a number of applications of reinforced concrete. 4000 w. Engineering Magazine—April, 1899. No. 26817 B.

Some Notable German Arch Bridges. Illustrated descriptions of some of the longest and, architecturally, most beau-

tiful bridges. 1100 w. Sci Am—March 25, 1899. No. 26638.

Competition.

Competition for Three Highway Bridges over the Flonthal at Lausanne. (Der Wettbewerb für drei Strassenbrücken über das Flonthal in Lausanne.) With illustrations of the premiated designs, and the report of the judges. Serial. Part 1. 2500 w. Schweizerische Bauzeitung—Feb. 25, 1899. No. 26749 B.

Concrete Arch.

Building a Concrete Arch. Series of views and detailed description of a good specimen of this class of work on the Erie & Pittsburg Div. of the Pennsylvania R. R. 1500 w. Ry Age—March 3, 1899. No. 26408.

Congo.

The Inkissi Bridge, Congo Railway. Illustrates and describes the erection of this bridge, which was attended with great difficulty. 1100 w. Engr, Lond—March 3, 1899. No. 26528 A.

Drawbridge.

Rebuilding of the Kinzie Street Drawbridge of the Chicago & Northwestern Ry. William H. Finley. Brief history of the old structure and illustrated description of the new. Discussion. 8000 w. Jour W Soc of Eng—Feb., 1899. No. 26832 D.

Floating Bridge.

The Floating Bridge at Lynn. C. J. H. Woodbury. An account of a unique wood bridge, built in 1803, which is still in use. It is essentially a very thick raft. 2000 w. Eng Rec—March 11, 1899. No. 26478.

Loads.

General Criterion for Position of Loads Causing Maximum Stress in Any Member of a Bridge Truss. L. M. Hoskins. A contribution toward the unification of the theory of maximum stresses due to moving loads. 6500 w. Pro Am Soc of Civ Eng—March, 1899. No. 26662 E.

Melan Arch.

Three-Span Melan Arch Bridge Across the Passaic River, Paterson, N. J. Brief illustrated description. 600 w. Eng News—March 16, 1899. No. 26557.

Paint.

Tests of Bridge Paint. Ira O. Baker. A summary of experiments. 1200 w. R R Gaz—March 10, 1899. No. 26453.

Railroad Bridge.

Bridge 69, New York Division, Pennsylvania Railroad. Illustrated description of a double-track deck structure of 235 feet span, built for heavy express traffic. Gives details of connections and supports. 1000 w. Eng Rec—March 4, 1899. No. 26669.

Reinforced Concrete.

The X Bridge at Mans. (Le Pont en X au Mans.) A description of this peculiar double intersecting bridge, giving an excellent discussion of the principles of reinforced concrete construction, of which it is an excellent example. 10000 w. 1 plate. Revue Technique—Feb. 10, 1899. No. 26708 D.

See Architectural Engineering, Construction.

Renewal.

The Temperanceville Bridge. Illustrated description of a three-tress, double-track deck bridge with interesting details. 1000 w. Eng Rec—March 4, 1899. No. 26400.

Rhine Bridge.

The New Bonn Bridge over the Rhine. A beautiful structure, costing about \$1,000,000 is illustrated and described. 800 w. Sci Am Sup—March 11, 1899. No. 26435.

Swing Bridge.

Chicago, Madison & Northern Swing Bridge Over Drainage Canal. Brief illustrated description of the longest and one of the largest bridges which will span this canal. 700 w. Ry & Engng Rev—March 4, 1899. No. 26413.

Trestles.

The Iron Trestle Bridges on the Waidhofen-Gaming Railway (Die Eiserne Gerüstbrücken der Localbahn Waidhofen-Gaming.) Oskar Meltzer. A description of some modern trestle railway bridges on an Austrian local road, with photographs and illustrations of details. 2500 w. Zeit d Oesterr Ing u Arch Ver—Feb. 24, 1899. No. 26731 B.

Trestle Bridge, Esquimalt and Nanaimo Railway, British Columbia. Sketch of trestle bridge, on a curve, with a grade, designed by J. A. L. Waddell. 700 w. Ind Engng—Feb. 4, 1899. No. 26429 D.

Trusses.

Notes on the Statics of Double-Braced Trusses (Beitrag zum Statisch Bestimmten Gegliederten Balkenträger mit Zweifachem Ausfüllsystem.) W. Dietz. An examination of various forms of framed structures, using the graphical treatment, including cantilevers, swing bridges, and arches. 2500 w. Zeit d Ver Deutscher Ing—March 4, 1899. No. 26726 D.

Vauxhall Bridge.

The New Vauxhall Bridge. A letter, signed by men of prominence, protesting against the design of this structure and urging the coöperation of competent architects; also the answer of the chairman of the Bridges Committee, and editorial. 3000 w. Builder—March 11, 1899. No. 26611 A.

CANALS, RIVERS AND HARBORS.

Docks.

Developments at Penarth Dock. Brief account of the work the Taff Vale Railway Co. is undertaking at this place. 1300 w. Engr, Lond—March 10, 1899. No. 26601 A.

Dry Docks—Stone vs. Wood. An informal discussion of this subject at a special meeting of the society. 18000 w. Pro Am Soc of Civ Engrs—March, 1899. No. 26663 E.

Floods.

Flood Forecasts. (La Prévision des Crues.) A very thorough discussion of the relations between rainfall and the rise of rivers, showing how the floods in certain rivers of France are predicted in advance; together with a discussion of the methods used in other countries. 5000 w. Revue Technique—Feb. 10, 1899. No. 26709 D.

Flow of Water.

The Character of Fluid Motion. Illustrated review of experiments by Prof. H. S. Hele-Shaw, showing the stream lines in flowing water. 1900 w. Eng Rec—March 4, 1899. No. 26398.

Isthmian Canals.

The Appointment of a Commission to Investigate Isthmian Canal Routes. Editorial criticism of the reported reappointment of the Walker Commission. 2700 w. Eng News—March 23, 189. No. 26643.

Manchester.

The Manchester Ship Canal. Elmer L. Corthell. Discusses the reasons for constructing this canal, and describes this great work and the results. Ill. 3000 w. Jour W Soc of Engrs—Feb., 1899. No. 26830 D.

N. Y. State Canals.

The Canals of the State of New York. Editorial comment on the appointment, by the Governor, of a special commission to investigate the policy of the state toward its canals. 800 w. R R Gaz—March 17, 1899. No. 26565.

Nicaragua Canal.

The Nicaragua Canal. Lewis M. Haupt. Digest of a lecture delivered before the Friends' Inst. Lyceum, Philadelphia. Briefly reviews the history of this project, discusses the objections urged, and the advantages claimed, and the commercial aspect. Ill. 2800 w. Sci Am Sup—April 1, 1899. No. 26828.

The Nicaragua Canal. Brief discussion of the project as it now appears, of the effect on trade routes, and the desirability of an Anglo-American understanding. 1700 w. Engng—Feb. 17, 1899. No. 26219 A.

Ottawa Valley.

The Montreal, Ottawa and Georgian

Bay Canal. A summary of the leading arguments given in a paper by Henry K. Wicksteed before the Can. Soc. of Civ. Engrs. 1300 w. Can Engr—March, 1899. No. 26544.

Soulanges.

The Soulanges Canal. Thomas Monro. Describes this canal and calls attention to the many essential features in which it differs in design from the other links of the St. Lawrence system. 12000 w. Can Engr—March, 1899. No. 26542.

Stettin.

The New Harbour Works at Stettin. (Die Neue Hafenanlagen in Stettin.) W. Zimmermann. A description of the important dock and canal construction works recently completed at Stettin, costing more than 12 million marks. 3000 w. 1 plate. Glasers Annalen—March 15, 1899. No. 26736 D.

IRRIGATION.

Drainage.

Immense Drainage Project. Richard H. Edmonds. An account of an irrigation development in the Arkansas river valley, in Prowers Co., Colorado, through the enterprise of New York capitalists. 3000 w. Mfrs Rec—March 3, 1899. No. 26336.

Montrose Canal.

The Montrose Irrigation Canal, Colorado. W. P. Hardesty. Illustrated description of features of interest of a canal which irrigates about 6000 acres. 2200 w. Eng News—March 23, 1899. No. 26641.

MISCELLANY.

Beams.

Bending Moments in Simple Beams Due to Wheel Loads. Thomas J. Brereton. The paper derives a formula for maximum bending moments due to non-uniform loads, and illustrates some of its uses. Ill. 2000 w. Sch of Mines Quar—Jan., 1899. No. 26589 D.

The Position of the Neutral Axis in Stone and Iron Beams. (Der Lage der Neutralen Achse im Gebogenen Balken aus Stein und aus Gusseisen.) E. Roser. A review of existing experiments by Barlow, Navier and Föppl, with a discussion of the results in the light of the elastic theory. 3500 w. Zeit d Ver Deutscher Ing—Feb. 25, 1899. No. 26725 D.

Bids.

The Right to Withdraw Erroneous Bids. Full text of a decision by the United States Circuit Court of Appeals in the case of Moffett, Hodgkins & Clarke Co. v. City of Rochester, which refuses to allow a contractor to withdraw a bid on the ground of mistake in the figures. 4500 w. Eng Rec—March 4, 1899. No. 26402.

Cement.

Silica Portland Cement. M. J. Butler. On the manufacture of this product, its

adaptability to certain uses, testing, etc. 1600 w. Can Engr—March, 1899. No. 26543.

Specifications for Portland Cement. Review of novel requirements for both slow and quick-setting cement for a large hydraulic power station. 1600 w. Eng Rec—March 11, 1899. No. 26479.

Cement Testing.

Comparative Tests on Different Forms of Cement Briquettes. Jerome Sondericker. Describes the manner of testing and discusses the conditions which should be considered in standard methods, as determined by results. 3000 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26331 C.

Foundations.

See Architectural Engineering. Construction.

Hydraulic Laboratory.

The Cornell Hydraulic Laboratory. J. H. Massie. Illustrated description of the reservoir, canal, penstock and laboratory proper, and a review of the proposed work to be done there. 3600 w. Eng Rec—March 4, 1899. No. 26399.

The Hydraulic Experiment Station of Cornell University. Information concerning the plant for making hydraulic experiments. Ill. 4800 w. Eng News—March 2, 1899. No. 26342.

Iron Protection.

Preservative Paints for Iron Chemically Considered. Explains the chemical nature and reaction of a simple red lead and red oxide of iron paint, so that the cause of incipient oxidation of the iron beneath the surface may be understood. 4000 w. Engng—Feb. 24, 1899. No. 26366 A.

Landslide.

The Landslide Disaster at Klappai in Bohemia. (Die Bergsturz Katastrophe bei Klappai in Böhmen). K. Kress. With photographs and a topographical map showing the nature of the disturbance, together with the engineering works for the prevention of a recurrence of the disaster. 3500 w. 2 plates. Oester Monatschr f d Oeffent Baudienst—March, 1899. No. 26747 D.

Models.

The Use of Models in Engineering. Shows the use of models in giving information and gives examples of fine works illustrating bridges, aqueducts, canals, and works in mining and metallurgy. 1800 w. Engr., Lond.—Feb. 24, 1899. No. 26375 A.

Road Construction.

The Massachusetts State Highway Report for 1898. Explains the reasons for the extra cost of the Massachusetts state roads as compared with those in New Jersey and gives an account of the methods of repairing roads which have proved most satisfactory. 3000 w. Eng Rec—March 25, 1898. No. 26671.

Topography.

The Application of Photography to the Production of Topographical Maps in Canada. (Sur de Nouvelles et Importantes Applications Faites au Canada de la Methode du Lever des Plans à l'Aide de la Photographie.) A. Laussedat. A communication to the French Academy upon the recent applications of photography to topographical surveying in Canada. 1800 w. Comptes Rendus—Feb. 27, 1899. No. 26745 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Cables.

See Measurement.

Coast Telegraphing.

Coast Telegraphic Communication. Charles Bright. Part first gives a review of the operations thus far carried out. 1800 w. Engr., Lond—Feb. 17, 1899. Serial 1st part. No. 26212 A.

Mine Signalling.

Electrical Communication in Mining Operations. W. E. Culbertson. A description of an installment by the D., L. & W. R. R. Co. for connecting the engine-room with the various slopes, shafts and veins. Ill. 2400 w. Mines & Min—March, 1899. No. 26391 C.

Electric Signals for Mine Hoists. (Elektrische Förderschälensignal Vorrichtung)

K. Dekanovsky. By using the hoisting rope in connection with a fixed conductor, a bell or telephone signal communication is maintained with the car at all times. 1200 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—Feb. 18, 1899. No. 26753 B.

Electrical Signalling Appliance for Cages. K. Dekanovsky in *Oesterreichische Zeitschrift für Berg und Hüttenwesen*. Illustrated description of the device. 1100 w. Col Guard—Feb. 24, 1899. No. 26361 A.

Multiplex.

Multiplex Telegraphs. Editorial on the value of multiplex principle to railroad service. Does not think it likely to be generally used for some time to come. 800 w. R R Gaz—March 17, 1899. No. 26564.

Newark, N. J.

Central-Office System of the Newark Telephone Co. Illustrates and describes the stations and operation of the system. 900 w. W Elect'n—March 11, 1899. No. 26507.

Printing Telegraph.

Successful Trial of the Rowland Multiplex Printing Telegraph. Between Philadelphia and Jersey City. Illustrates this apparatus, stating the advantages of the system. 1000 w. Elec Eng, N. Y.—March 2, 1899. No. 26316.

Repeaters.

New Telephone Repeater. James Asher. Describes the writer's method of combining Edison's loud-speaker with a carbon or other transmitter to produce loud speech at the end of a second circuit, or of an indefinite number of circuits. 1800 w. Elec Rev, N. Y.—March 15, 1899. No. 26540.

Space Telegraphy.

Various Forms of Detectors for Magnetic Space Telegraphy. Dr. Oliver Lodge. Abstract of a paper read before the Inst. of Elec. Eng. Illustrates and describes a number of devices. 1800 w. Elec Eng, N. Y.—March 2, 1899. No. 26315.

Wireless Telegraphy. G. Marconi. Read before the Inst. of Elec. Engs., England. Describes a series of very successful experiments with the writer's system, and calls attention to the importance of this method in naval and military operations. Ill. 6700 w. Ind & Ir—March 10, 1899. No. 26593 A.

Stock Reporting.

The Rise of the Stock Reporting Telegraph. Ralph W. Pope. Gives the history of the gold indicator, and stock reporting; the instruments used and by whom invented, and facts of interest in this connection. 3000 w. Elec Wld—March 2, 1899. No. 26320.

Submarine.

Submarine Telegraphs. Remarks on the submarine telegraphs of the world, and the practicability of a line across the Pacific. 1600 w. Bos Jour of Com—March 11, 1899. No. 26501.

The Developments of the Submarine Telegraph. From a statement prepared by the Treasury Bureau of Statistics, giving an outline of the history and the part America has had in the development. 1800 w. Arch & Build—March 11, 1899. No. 26464.

DISTRIBUTION.**Converters.**

Action and Tension Available at the Brushes of a Converter. (Fonctionnement et Tension Disponible aux Balais d'une Commutatrice.) M. Aliamet. A study of the action of rotary converters, and the

various methods of transforming currents possible by their use. 1500 w. L'Elec-tricien—Feb. 25, 1899. No. 26773 B.

Insulation.

Insulation Measurements in Three-wire Circuits with Insulated Middle Wire. (Isolationsmessungen an Dreileiteranlagen mit Isolirten Mittelleiter.) Dr. J. Kollert. The method is described, and an example in its application fully worked out. 1200 w. Elektrotech Zeitschr—March 2, 1899. No. 26768 B.

Interrupter.

Observations on the Wehnelt Interrupter. George T. Hanchett and Charles T. Child. Describes experimental reseaches by the writers with the view of determining the best form to be given the interrupter and how it might best serve the purpose for which it was intended. States conclusions. Ill. 2000 w. Elec Wld & Elec Eng—March 25, 1899. No. 26651.

The Use of the Wehnelt Interrupter. Louis S. Levy. Gives results obtained in using the interrupter, stating the comparative effects of the Wehnelt interrupter and the ordinary form of vibrator. 800 w. Elec Wld & Elec Eng—March 25, 1899. No. 26652.

The Wehnelt Electrolytic Current Interrupter. Elihu Thomson. Reports experiments made by the writer with this interrupter for use with induction coils and the remarkable results. Ill. 200 w. Elec Eng, N Y—March 2, 1899. No. 26313.

The Wehnelt Electrolytic Interrupter. Elihu Thomson. Observations recently made on this interrupter, the applications and methods of working. 1400 w. Elec Wld & Elec Eng—March 18, 1899. No. 26581.

Rotary Equalizer.

Practical Applications of the Rotary Equalizer. Charles B. Davey. Gives applications of this device by means of which the potentials between the two sides of a three-wire system is maintained at a balance. 1700 w. W Elect'n—March 18, 1899. No. 26630.

Three-Wire System.

Saving by the Three-Wire System. Alton D. Adams. Shows that for a given number of lamps equal energy is lost in the two-wire and three-wire systems, and that the weight of conductors is only one-fourth as great for the three-wire as for the two-wire system. 1300 w. Am Elect'n—March, 1899. No. 26496.

Wiring.

Electric Wiring Rules. Editorial on the papers of R. E. B. Crompton, C. H. Wordingham, and J. Pigg, presented and discussed at a recent meeting of the Brit. Inst. of Elec. Engs. 2500 w. Engng—Feb. 17, 1899. No. 26221 A.

Modern Systems of Interior Wiring. L.

B. Chubbuck. Read before the Engng. Soc. of the School of Prac. Science, Toronto. Reviews the methods of wiring used since the introduction of electric lighting, and describes the systems in use at present. Ill. 4500 w. Can Elec News—March, 1899. No. 26570.

ELECTRO-CHEMISTRY.

Accumulators.

Accumulators for Electric Automobiles of the Société Anonyme Pour le Travail Electrique des Métaux. Describes a storage battery specially devised with reference to the requirements of the electric cab. 600 w. Elec Rev, Lond—Feb. 24, 1899. No. 26379 A.

Gas Electric Accumulators. (Les Accumulateurs Electriques à Gaz.) Max de Nansouty. A discussion of the Cailletet and Collardeau gas battery, using the electrolysed gases of liquids other than water, and at pressures of more than 500 atmospheres. 1800 w. L'Electricien—March 11, 1899. No. 26776 B.

Electric Smelting.

The Electrolytic Winning of Metals Direct from the Ore. (Elektrolytische Gewinnung von Metallen Direkt aus Erzen.) Dr. W. Borchers. A discussion of the recent paper of Dr. Höpfner, criticising details, but confirming the practicability of the processes. 1500 w. Zeitschr f Elektrochemie—March 2, 1899. No. 26780 G.

Electrolysis.

Experiment in Electrolysis Without Electrodes. (Experiment über Elektrolytische Leitung ohne Elektroden.) Dr. Behn-Eschenburg. A non-conducting trough containing the electrolyte is fitted around the iron core of a transformer, and a current is induced in the liquid. 1200 w. Zeitschr f Elektrochemie—March 2, 1899. No. 26779 G.

Electro-Metallurgy.

Recent Progress in Electrometallurgy. (Ueber die Neueren Fortschritte der Elektrometallurgie.) E. Andreoli. A general review of work in electrometallurgy on the continent as well as in the United States and England. 2000 w. Elektrochemische Zeitschr—March 1, 1899. No. 26781 G.

Nickel Plating.

Apparatus for Nickel Plating Numerous Small Objects at a Time. From *Revue Industrielle*. Calls attention to the great care necessary in preparing the objects, and describes the arrangements employed for the immersion in the bath. Ill. 1200 w. Sci Am Sup—March 4, 1899. No. 26293.

Vanadium.

A Note on the Electro-Deposition of Vanadium. Sherard Cowper-Coles. Where found, prices, etc., with some of its char-

acteristics. 500 w. Elec Rev, Lond—Feb. 17, 1899. No. 26231 A.

ELECTRO-PHYSICS.

Alternating Currents.

Alternating Currents Twenty-five Years Ago, and To-day. Edwin J. Houston and A. E. Kennelly. The changes in the application and use of alternating currents are reviewed. 2200 w. Elec Wld—March 4, 1899. No. 26319.

Cathode Rays.

The Reflection of Cathode Rays. A. A. Campbell Swinton. Abstract of a paper communicated to the Royal Soc. Investigations which show that the field of reflected cathode rays is not uniform, but increases on both sides to a maximum. 600 w. Elec Eng, Lond—March 3, 1899. No. 26513 A.

Currents.

Some Experiments in Tesla's Laboratory with Currents of High Potential and High Frequency. Nikola Tesla. Illustrated description. 4000 w. Elec Rev, N. Y.—March 29, 1899. No. 26825.

Generation.

Electricity Generated Direct from Coal. (L'Electricité Obtenue Directement par Combustion du Charbon.) E. Lievenie. A review of the various methods which have been proposed since the time of Becquerel in 1855. 1500 w. Revue Technique—Feb. 25, 1899. No. 26711 D.

GENERATING STATIONS.

Armatures.

On the Dimensioning of Armatures. George T. Hanchett. The effect of lengthening the drum armature is discussed, showing that in general long armatures are to be avoided. 1500 w. Elec Wld & Elec Eng—March 11, 1899. No. 26472.

The Theory of Armature Windings. (Beitrag zur Theorie der Ankerwickelungen.) Ch. Westphal. A brief mathematical discussion, with especial reference to continuous current dynamos. 1200 w. Elektrotech Zeitschr—Feb. 9, 1899. No. 26759 B.

Bankside Station.

The City of London Electric Lighting Company. Part first gives an illustrated general description of the Bankside station, which is said to be the largest station for lighting purposes in the world. 2800 w. Engr, Lond—March 10, 1899. Serial. 1st part. No. 26602 A.

Boston, Mass.

The Isolated Plant of the New Boston Railway Terminal. H. W. Weller. Illustrated description of the power plant for the heat, light and ventilation, the operation of elevators, supply of hot and cold

water, making ice, pumping, electro-pneumatic switching, and signaling. 6600 w. Elec Wld & Elec Eng—March 11, 1899. No. 26471.

Brazil.

Electric Light and Power Plant at Para. Brazil. An illustrated description of the plant, and some of the difficulties encountered in a tropical country. 3500 w. Elec Eng, N. Y.—March 2, 1899. No. 26314.

City of London.

The City of London Electric Lighting Company's Works. A brief account of the formation of the company and illustrated description of some of the details. 1800 w. Elec Rev, Lond—March 3, 1899. Serial. 1st part. No. 26515 A.

Converters.

Rotary Converters. (Les Convertisseurs Rotatifs.) A discussion of the construction and action of the rotary converter, with illustrations of various designs. 2500 w. Génie Civil—March 11, 1899. No. 26707 D.

Dynamos.

Dynamo and Engine Capacities. Alton D. Adams. On the importance of giving attention to combined operative efficiency under average working conditions. 1400 w. Engr. U. S. A.—March 1, 1899. No. 26410.

Electrical Things That Are Not What They Seem. Alton D. Adams. Critical review of the claims of a new electric generator recently advertised. 1200 w. Elec Wld & Elec Eng—March 18, 1899. No. 26583.

Signal-Current Generators for Telephone Exchanges. H. P. Clausen. Illustrates the generators and describes the operation. 2000 w. W Elect'n—March 4, 1899. No. 26424.

Equalizing.

Two-Rate Charging from the Consumer's Standpoint. Lyman C. Reed. Thinks the system very unsatisfactory, and that the question is solved by the use of accumulators, thus doing away with the excessive engine peak at certain hours. 1300 w. Am Elect'n—March, 1899. No. 26497.

Fuse.

The Electric Fuse. Alton D. Adams. Describes the electric fuse and the advantages gained through its use. 1000 w. Sci Am—March 4, 1899. No. 26291.

High Wycombe.

High Wycombe Electricity Works. Illustrates and describes this installation. 4800 w. Elec Eng, Lond—March 3, 1899. No. 26512 A.

Lincoln, England.

Lincoln Corporation Electric Supply

Works. Illustrated detailed description. 1800 w. Elect'n, Lond—March 3, 1899. No. 26516 A.

New York City.

Foundations and Chimney for 45,000-H.P. Electric Power Station, Metropolitan Street Railway Co., New York City. Illustrated description of the details of the chimney and foundations of one of the two largest power stations in the world. 1800 w. Eng News—March 2, 1899. No. 26345.

Oscillation.

The Oscillation of Parallel Connected Dynamos. (Das Pendeln Paraleli Geschalteter Maschinen). Gisbert Kapp. A discussion of the best methods of preventing the oscillations which sometimes appear in direct-driven dynamos which are connected in parallel. 4000 w. Elektrotech Zeitschr—Feb. 16, 1899. No. 26761 B.

South Africa.

The Electric Power Plant at Johannesburg. Die (Elektrische Kraftübertragungsanlage bei Johannesburg.) Walter Klug. A description of the large plant of the Rand Central Electric Works, which supplies light and power to the mines of the district. 6000 w. Glückauf—Feb. 18, 1899. No. 26751 B.

Sparking.

The Limit of Load Without Sparking. (La Limite de la Marche sans Etincelles.) A mathematical discussion of the cause of sparking in continuous current dynamos, showing the conditions under which a minimum degree of sparking may be secured. 2000 w. Revue Technique—Feb. 25, 1899. No. 26710 D.

The Limits of Sparking With Continuous-Current Dynamos. Gisbert Kapp. Abstract translation from *Elektrotechnische Zeitschrift*. A generally applicable formula, based on scientific reasoning, is given, so simple as to admit of its employment by practical men. 2500 w. Elec Eng, Lond—Feb. 17, 1899. No. 26233 A.

Switches.

Circuit Breakers and Interrupters (Coupe-Circuits a Interrupteurs.) A general discussion by various members of the society, with a view of unifying construction and establishing standards. Two papers. 10000 w. Bull de la Soc Int des Electriciens—Jan., Feb., 1899. No. 26771 each F.

Double Switch System for Accumulators. (Doppelzellenschalter für Akkumulatoren.) H. Müller. A description of the switch and distribution system used in connection with the accumulators at the power house at Barmen, Germany. 1500 w. Elektrotech Zeitschr—Feb. 23, 1899. No. 26763 B.

Transformer.

A Discussion of the Operation of the Alternating-Current Transformer. (Über Auffassung und Darstellung der Vorgänge im Wechselstromtransformator.) Dr. C. Heinke. A very thorough mathematical treatment, using both graphical and analytical methods. Three articles, 12,000 w. *Elektrotech Zeitschr*—Mar. 2, 9, 16, 1899. No. 26766 each B.

Tyrol.

The Electric Plants in the Tyrol, the Voralberg and Trent. (Le Officine Elettriche nel Tirol e Voralberge nel Trentino.) E. Lanzerotti. A general review of the development of the power of the Tyrolese Alps and its electrical distribution. 2000 w. *L'Elettricità*—March 4, 1899. No. 26794 B.

HEATING AND WELDING.**Warming.**

The Le Roy Process for Warming by Electricity. (Le Chauffage Electrique par les Buches Le Roy.) An illustrated description of this improved apparatus. The heat is produced by passing the current through rods of silicon in vacuum tubes. Radiators and other applications are shown. 800 w. *L'Electrician*—Feb. 25, 1899. No. 26772 B.

Welding Transformer.

Miscellaneous Shop Uses of the Welding Transformer. George T. Hanchett. Notes briefly some of the applications. 700 w. *Am Mach*—March 23, 1899. No. 26665.

LIGHTING.**Arcs.**

Series Arc Lighting. W. H. Turbayne. Read before the C. A. S. E. An explanation of the principles involved, with a short description of the functions of the mechanisms employed in a modern system in which a direct current of constant value is employed. 1800 w. *Can Engr*—March, 1899. No. 26545.

Canterbury.

Canterbury Electric Light Works. Illustrated detailed description. 4000 w. *Elec Eng, Lond*—March 10, 1899. No. 26616 A.

Cost.

Cost of Electric Light. Alton D. Adams. Considers some of the reasons for difference in cost as compared with gas, and the ways in which the charge is regulated. 1000 w. *Sci Am*—March 11, 1899. No. 26432.

Incandescent Lamps.

The Difference Between Good and Bad Incandescent Lamps. Francis W. Willcox. On the means of distinguishing between good and bad lamps, with a short account of the Standard Oil Co.'s lamp

test. 4000 w. *Elec Wld & Elec Eng*—March 18, 1899. No. 26582.

Nernst Lamp.

Forerunners of the Nernst Lamp. Calls attention to other workers in this field who have apparently anticipated this invention. 2500 w. *Elec. Rev, Lond*—Feb. 24, 1899. No. 26380 A.

Nernst Lamp v. the Arc and Incandescence Lamps. John I. Hall. Part first gives attention to the cost and concludes in this matter at least the Nernst lamp has not the advantage. 1200 w. *Elec Rev, Lond*—March 17, 1899. Serial. 1st part. No. 26801 A.

The Incandescence of Refractory Electrolytes. Editorial discussion of Prof. Nernst's invention, and of the neglected discoveries which anticipated it. Ill. 2800 w. *Engng*—March 3, 1899. No. 26523 A.

Report.

The Growth of Electric Lighting in New York City. Data from the annual report of R. R. Bowker, relating to the work of the corporation to date and its plans for the future. Ill. 2000 w. *Elec Wld & Elec Eng*—March 18, 1899. No. 26580.

MEASUREMENT.**Cables.**

The Determination of the Electrical Capacity of Telephone Cables with Double Conductors. (Ueber die Bestimmung der Elektrischen Kapazität von Fernsprechkabeln mit Doppelleitungen.) F. Breisig. A mathematical discussion of the practical methods used by the Imperial postal telegraph system. 6000 w. *Elektrotech Zeitschr*—Feb. 9, 1899. No. 26760 B.

Conductors.

Tests of Conductors for 10,000 volts. (10,000 V-Kabelversuche.) A. Hassold. Tabulated data and results of tests made on the long-distance transmission between Bozen and Meran, Austria. 1800 w. *Elektrotech Zeitschr*—March 9, 1899. No. 26769 B.

Hysteresis.

The Blondel-Carpentier Hysteresis Meter. (Der Hysteresismesser Blondel-Carpentier.) A brief description, with illustrations. The principle is the same as that of the Ewing rotary hysteresis meter. 800 w. *Elektrotech Zeitschr*—March 2, 1899. No. 26767 B.

Measurement.

Measurements on Telephone Conductors. (Messungen an Fernsprechverbindungsleitungen.) F. Breisig. A mathematical discussion of the method used on the Berlin telephone system; employing alternating currents. 5000 w. *Elektrotech Zeitschr*—March 9, 1899. No. 26770 B.

Meter Testing.

Meter Testing and Handling. James E.

Judd. Illustrates and describes the method and equipment of a testing department. 900 w. *Am Elect'n*—March, 1899. No. 26494.

Stray Currents.

A System for the Control of Stray Currents of Electric Tramways. (System zur Kontrolle der Vagabondirenden Ströme Elektrischer Bahnen.) Dr. M. Kallmann. Mainly devoted to methods of measuring stray currents; comparing German and American practice. 10,000 w. *Elektrotech Zeitschr*—Feb. 23, 1899. No. 26765 B.

POWER APPLICATIONS.

Agriculture.

The Electric Lighting and Power Plant on the Lancken Estate. (Elektrische Beleuchtungs und Kraftübertragungsanlage auf dem Rittergut Lancken.) An illustrated account of a complete agricultural plant on a large estate in Rügen, Prussia, showing numerous applications of electric power to agricultural work. 1200 w. *Elektrizität*—March 4, 1899. No. 26782 B.

Electric Cabs.

See Mechanical Engineering, Automobilmism.

Electric Locomotives.

See Railway Affairs, Motive Power.

Italian Navy.

See Military Engineering.

Lift.

Passenger Lift Equipment for the Central London Railway. States the general conditions for the tenders of these elevators, with an illustrated description of the equipment, which is of American design and make. 1400 w. *Engng*—March 3, 1899. Serial. 1st part. No. 26519 A.

Marine Auxiliaries.

Electricity on Board Ship. S. Dana Greene. Considers principally the application to war vessels, but is equally applicable to merchant marine. Also discussion. 17500 w. *Trans Am Inst of Elec Eng*s—Jan, 1899. No. 26661 D.

Motor.

How to Make a Sewing Machine Motor Without Castings. Cecil P. Poole. Drawings and instructions for building an efficient motor that will operate the heaviest family sewing machine with a consumption of electrical energy only slightly greater than that required for an incandescent lamp. 5500 w. *Sci Am Sup*—March 11, 1899. No. 26433.

Motor Design.

Design of a $\frac{1}{4}$ H. P. Single-Phase Induction Motor. P. M. Heldt. Describes a motor designed to be built by amateurs. 2700 w. *Am Elect'n*—March, 1899. No. 26495.

Power Station.

See Street and Electric Tramways.

Printing.

Electricity in Printing, Binding and Engraving. Illustrates and describes special applications of the electric motor. 2500 w. *Am Elect'n*—March, 1899. No. 26493.

Propulsion.

Electric Propulsion for Torpedo Boats. (La Propulsion des Torpilleurs par l'Electricité). George Davy. An extended review of a recent paper by C. T. Child on this subject. 1800 w. *L'Electricien*—March 18, 1899. No. 26795 B.

Electric Propulsion for Torpedo Boats. W. F. Durand. A criticism of C. T. Child's article on the same subject giving many data and arguing that the present limitations of electrical application prevent the use of battery-driven boats. 6000 w. *Jour Am Soc of Naval Eng*s—Feb., 1899. No. 26491 H.

Pumps.

Electric Pumps and Pumping. A. W. K. Pierce. Deals with the disposal of underground water in mining, assuming that electric pumps are to be used; discusses the type, the system of transmission, apparatus, size, capacity, etc. Ill. 4000 w. *Ir & Coal Trds Rev*—Feb 17, 1899. No. 26209 A.

Shop Practice.

See Mechanical Engineering, Machine Works and Foundries.

Speed.

The Stroboscopic Method of Determining the Speed of Small Motors. (Stroboskopische Methoden zur Bestimmung der Umdrehungszahl Kleiner Motoren.) G. Benischke. The speed is determined by viewing the fan driven by the motor to be tested through openings in a disk driven by another motor of known and controlled speed. 1800 w. *Elektrotech Zeitschr*—Feb. 16, 1899. No. 26762 B.

Wolverhampton.

The Electric Construction Company's Works at Wolverhampton. Gives a short history of the development and an illustrated description. 2800 w. *Elect'n, Lond*—March 10, 1899. No. 26617 A.

TRANSMISSION.

Address.

The Past, Present and Future of Electric Power Transmission. (Vergangenheit, Gegenwart, und Zukunft der Elektrischen Kraftübertragung.) Josef Kareis. An interesting address delivered before the Technical Association of Lower Austria, giving a general review of the situation. Two articles. 3500 w. *Electro-Techniker*—Feb. 28, March 1, 1899. No. 26785 each B.

Conductors.

See Measurement.

High Voltage.

High Voltage Transmission. Editorial review of experiments made in America, and the paper of Charles F. Scott, read before the Am. Inst. of Elec. Eng. 2400 w. Engng—Feb. 24, 1899. No. 26367 A.

Insulation.

The Insulation of Overhead Electric Lines. (Insolement des Lignes Electriques Aériennes.) A. Fleury. A discussion of the relative merits of glass and porcelain, with methods of testing their behaviour in moist weather. 1800 w. L'Electricien—Feb. 25, 1899. No. 26774 B.

Long Distance.

Water-Power Plants with Long-Distance Electric Transmission in Southern California. C. E. Fowler. Introductory remarks on the extent of these plants, with illustrated description of that recently completed by the Southern California Power Co. 5000 w. Eng News—March 9, 1899. Serial. 1st part. No. 26443.

Three-Phase.

Three-Phase Transmission for Electric Railway Work in Maine. Describes the system of the Lewiston, Brunswick & Bath street railway. Ill. 1300 w. St Ry Jour—March, 1899. No. 26417 D.

MARINE ENGINEERING

Collisions.

The Prevention of Collisions at Sea During Foggy Weather. Describes a system for the prevention of collisions at sea during foggy weather, which was invented by N. Bottone. 1400 w. Steamship—March, 1899. No. 26510 A.

Condenser.

Official Report on the Operation of Ericsson's Surface Condenser and Evaporator for Marine Engines—1847. Copy of a document interesting to naval engineers. 2500 w. Jour Am Soc of Naval Eng—Feb., 1899. No. 26492 H.

Corrosion.

The action of Sea Water Upon Copper Alloys. (Die Bestandigkeit der Gebrauchlichsten Kupferlegierungen im Seewasser.) A discussion of the experiments made by the German navy, upon the alloys most generally used for sheathing vessels. Two articles, 5000 w. Stahl und Eisen—Feb. 15, Mar. 1, 1899. No. 26739, each D.

Dredges.

High Powered Dredges and Their Relations to Sea and Inland Navigation. Lindon W. Bates. Part first considers the evolution of modern hydraulic dredging, various types of dredges and their characteristics. Ill. 5000 w. Naut Gaz—

MISCELLANY.**Atmospheric Electricity.**

The Origin of Atmospheric Electricity. Prof. Cleveland Abbe, in the *U. S. Monthly Weather Review*. Notes the suggestions of many scientists, but considers the tests have given only negative results, and that the problem is still unsolved. 1400 w. Nature—March 9, 1899. No. 26615 A.

Education.

The Education of Electrical Apprentices and Journeymen. Arthur A. Hamerschlag. On the desirability of training young men to be efficient electrical workers. Discussion. 6400 w. Trans Am Inst Elec Eng—Jan., 1899. No. 26660 D.

Lightning Protection.

Approved Lightning Protection. Nevil Monroe Hopkins. On the historic and modern lightning-rod and its incorrect application. Ill. 3700 w. Sci Am Sup—March 25, 1899. No. 26640.

Symposium.

The Advantages and Disadvantages of the Electrical Profession. Extracts from the address and symposium presented at the meeting of the Electrical Club of the Young Men's Christian Ass'n, of Chicago. 4000 w. Elec Wld—March 4, 1899. No. 26318.

March 9, 1899. Serial. 1st part. No. 26463.

Fog.

Navigation in Foggy Weather. (Navigation en Temps de Brouillard.) E. Lacoine. A discussion of a system of signal stations, producing audible signals and forming a sort of block-system, for use in harbours and similar situations. 2000 w. Revue Technique—March 10, 1899. No. 26719 D.

Freeboard.

Some Considerations on Freeboard and on the Relation between Scantlings and Freeboard. Archibald Hogg. Read before the North East Coast Institution of Engineers and Shipbuilders. An investigation of the freeboard question, giving tables. 2300 w. Engs' Gaz—March, 1899. No. 26427 A.

Marine Auxiliaries.

See Electrical Engineering, Power Applications.

Marine Engines.

Engines of the S. S. "Ultonia." Two page plate, with description. 1300 w. Engng—March 3, 1899. No. 26520 A.

The Engines of H. M. S. Goliath. Illustrated description. 800 w. Engr, Lond—Feb. 24, 1899. No. 26376 A.

Mercantile Marine.

The Conditions of the German Mercantile Marine. Details from Mr. Gastrell's recent report on the commercial and maritime interests of Germany. Its mercantile marine is now the third largest in the world. 2800 w. *Ir & Coal Trds Rev*—March 3, 1899. No. 26532 A.

Raising.

Raising Sunken Vessels. From *La Nature*. Illustrates and describes the methods used in raising the "Rossia," in the river Neva, and the British iron-clad, "Victorious," near Port Said. 1300 w. *Sci Am*—March 4, 1899. No. 26290.

Russia.

Some Notes in Russia. Deals with Russian dockyards. Part first discusses the New Admiralty Yard, St. Petersburg. Ill. 2200 w. *Engr, Lond*—Feb. 24, 1899. Serial. 1st part. No. 26373 A.

Ship-Building.

The Prospective Expansion of American Shipbuilding. G. R. Dunell. An

examination of the coming American competition, showing that the command of the steel trade is the key to the control of the shipbuilding industry. 4500 w. *Engineering Magazine*—April, 1899. No. 26822 B.

Ship Lighting.

Consideration of the Voltage Used in Electric Ship Lighting. Alton D. Adams. Advises the 100-volt pressure as best suited for a ship's plant at the present time. 1000 w. *Marine Engng*—March, 1899. No. 26335 C.

Steamship.

New Oil-Carrying Steamship. Illustrated detailed description of the steel screw steamer *Atlas*. 4400 w. *Naut Gaz*—Feb. 23, 1899. Serial. 1st part. No. 26266.

The Ponce and the San Juan. Illustrated description of the two new steamships now under construction at the shipyard of the Harlan & Hollingsworth Co., for the Porto Rico trade. 1300 w. *Naut Gaz*—March 2, 1899. No. 26337.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Air Resistance.

Air Resistance to Moto Cars. H. E. Wimperis. Comments on the little known of this subject, and suggests methods of making experiments. 1500 w. *Automotor Jour*—Feb., 1899. No. 26264 A.

Commercial Operation.

The Motor Vehicle in Commercial Operation. G. Herbert Condict. Considers the electric motor the form of power presenting the least objectionable features, discusses the station, wheels, etc. 1800 w. *Elec, N. Y.*—March 1, 1899. No. 26294.

Contest.

The Boston (U. S. A.) Moto-Vehicle Contest. An account of the entries and the points considered, with extracts from the judges' report. 4000 w. *Automotor Jour*—Feb. 15, 1899. No. 26262 A.

Design.

Some New Features in Motor-Vehicle Design. Thomas H. Parker. Read before the Liverpool Self-propelled Traffic Assn. Describes the work of the writer in this field and the success attained. 2800 w. *Ind & Ir*—March 3, 1899. No. 26530 A.

Disaster.

The Harrow Moto-Car Accident. Description of the accident which caused the loss of two lives, and which is attributed to faulty design or imperfection in a wheel. Report of the inquest, letter, and discussion of the cause. 3300 w. *Auto-*

motor Jour—March 15, 1899. No. 26697 A.

Driving-Wheels.

The Design of Driving-Wheels. A discussion of needed improvements in design to satisfy the requirements of safety and comfort. Suggested by the Harrow accident. 1200 w. *Automotor Jour*—March 1899. No. 26699 A.

Electric Cabs.

Electric Cabs in Paris. Remarks on the automobile cab competition held some time ago in France, with a description of the cabs of the *Compagnie Générale*. Ill. 2500 w. *Engng*—Feb. 24, 1899. Serial. 1st part. No. 26365 A.

Evolution.

The Evolution of the Motor-Car. E. Shrapnell Smith. Excerpt from a paper read before the Univ. College Students' Engng. Soc. Thinks the problems most pressing are to combine strength, lightness and efficiency and to secure sufficient adhesion on greasy surfaces. 1100 w. *Automotor Jour*—Feb., 1899. No. 26263 A.

Military Transport.

Automotors and Military Transport in Campaigns. M. de Capitaine Bardonant in *La Revue du Cercle Militaire*. Abstract and criticism of an article by Major Mirandoli, published in the *Rivista di Artiglieria e Genio*. 2000 w. *Automotor Jour*—March 15, 1899. No. 26695 A.

Steam.

The Application of Steam to Self-con-

tained Road Vehicles. Excerpt from a paper read before the Liverpool Self-propelled Traffic Essn., by W. Norris. Discusses the writer's view of the correct lines on which a successful steam motor-driven vehicle should be designed. 2500 w. *Automotor Jour*—Feb., 1899. No. 26-265 A.

Tractor.

A Road Ring-Rail Tractor. Illustrated description of a German solution of the problem of diminishing resistance caused by uneven roads. 1200 w. *Automotor Jour*—March 15, 1899. No. 26696 A.

Tyres.

Pneumatic Tyres for Moto-Vehicles. S. F. Edge. Excerpt from a paper read before the Automobile Club. Considers cost, advantages and disadvantages. 2000 w. *Automotor Jour*—March 15, 1899. No. 26698 A.

HYDRAULIC ENGINEERING.

Centrifugal.

Centrifugal Pumps. W. H. Booth. On the work of these pumps, their speed, efficiency, etc. 3000 w. *Am Mach*—March 2, 1899. No. 26383.

The Present Status of the Centrifugal Pump. Henry P. Jones. Gives a study and comparison of collected data, discussing the class of pumps not built for particular conditions, but intended to satisfy the general demand. 2800 w. *Eng News*—March 9, 1899. No. 26447.

Italy.

Concessions for Hydraulic Power. (Le Concessioni di Forze Idrauliche.) A discussion of the quantity of hydraulic power available in Italy, and the probable cost of its electrical transmission to points of application; in view of the granting of concessions to undertakers for its development. Two articles, 3500 w. *Rivista Gen d Ferrovie*—Jan. 8, 15, 1899. No. 26793, each B.

Power Development.

Early Development of Water Power in the United States. J. T. Fanning. Extract from a paper read at meeting of the Am. Pulp & Paper Assn. Review of the water power history and development, which began in early colonial times. 2500 w. *Eng News*—March 2, 1899. No. 26346.

Pumping Engines.

See Municipal Engineering. Water Supply.

Pumps.

See Steam Engineering.

Suction Pipes.

The Mechanics of Suction and Suction Pipes. Daniel W. Mead. Considers in detail the local conditions and mechanical arrangements which determine the height

at which the pump cylinder may be set above the water level. 1200 w. *Jour W Soc of Eng*—Feb., 1899. No. 26831 D.

MACHINE WORKS AND FOUNDERIES.

Blowers.

The Relation of Velocity and Pressure in Centrifugal Blowers. Alton D. Adams. Investigations to find which of two statements is correct, and pointing out an error in Mr. Snell's formula. Also editorial discussion. Ill. 3200 w. *Eng. News*—March 9, 1899. No. 26444.

Boring.

A Large Special Horizontal Boring and Milling Machine—"Made in Germany." Half-tone and drawing showing an interesting machine built by Droop & Rein. Bielefeld, Germany. 500 w. *Am Mach*—March 9, 1899. No. 26421.

Chilled Rolls.

See Mining and Metallurgy, Iron and Steel.

Castings.

Coke and Charcoal Iron for Malleable Castings. Erastus C. Wheeler. Considers some of the comparable qualities in each iron, giving deductions gathered from experience. 2000 w. *Ir Age*—March 30, 1899. Serial. 1st part. No. 26826.

To Make Straight Castings. P. R. Ramp. Suggestions with illustrations. 500 w. *Foundry*—March, 1899. No. 26633.

Cast Iron.

Cast Iron. Dr. R. Moldenke. Considers chemical properties, the making, tests, etc. 2200 w. *R R Gaz*—March 10, 1899. No. 26457.

Cores.

Round Cores and Prints. From the *English Mechanic*. Remarks on the common round or square print fastened on the top and bottom faces of a pattern, to carry a vertical core. 2800 w. *Prac Engr*—Feb. 24, 1899. No. 26386 A.

Cranes.

Patterns for Crane Checks. Joseph Horner. Illustrates and describes methods of constructing. 1300 w. *Am Mach*—March 16, 1899. No. 26549.

Drill.

A Five-Spindle Drilling Attachment. A. H. Cleaves. An illustrated detailed description of the tool. 600 w. *Am. Mach*—March 2, 1899. No. 26382.

The Davis Calyx Drill. Illustrates and describes this drill and its achievements, stating the principal advantages. 1800 w. *Col Guard*—Feb. 17, 1899. No. 26226 A.

Fly Wheels.

Fly-wheel Explosions. (Ueber Schwungrad explosionen.) J. Goebel. A mathematical examination on the centrifugal stresses tending to produce explosions of fly-wheels. 1500 w. *Zeit d ver Deutscher Ing*—March 4, 1899. No. 26727 D.

Gauges.

Wire Gauges. S. H. Stupakoff. Read before the German Engs.' Soc. at Pittsburgh. Gives list of gauges in use, discussing their form and material, variations, advantages and disadvantages, etc. 2800 w. Ir Trd Rev—March 23, 1899. Serial. 1st part. No. 26647.

Hardening.

See Mining and Metallurgy, Iron and Steel.

Jigs.

Two Milling Jigs. A. H. Cleaves. Illustrates and describes two jigs, whose most important feature is said to be the facility they afford for taking a heavy cut with a small hold on the work. 800 w. Am Mach—March 9, 1899. No. 26420.

Machinery.

See Mining and Metallurgy, Miscellany.

Molding.

Molding a Road-Wheel in Loam. Joseph Horner. Illustrates and describes wheels made in this way to save the expense of making full patterns. 1200 w. Mech Wld—March 17, 1899. No. 26693 A.

Premium Plan.

Experience with the Premium Plan of Paying for Labor. F. A. Halsey. Outlines the plan which was described eight years ago, and presents data concerning its working in a well-known manufacturing corporation, which has had the plan on trial for two years, showing that it does what is claimed. 4000 w. Am Mach—March 9, 1899. No. 26419.

Some Questions Regarding the Premium Plan with Answers to Them. F. A. H. Discusses the applicability of the plan to stated conditions. 1800 w. Am Mach—March 23, 1899. No. 26666.

Printing Machinery.

Machinery for Book and General Printing. William Powrie. Read before the Inst. of Mech. Engs., England. Deals with the leading types of machines used for book and job printing. Ill. 3000 w. Engng—March 10, 1899. Serial. 1st part. No. 26598 A.

Rolling Mill.

See Mining and Metallurgy. Iron and Steel.

Rolls.

See Mining and Metallurgy, Iron and Steel.

Sheffield Works.

Victoria Works, Sheffield. Illustrates and describes an extension of these works for the manufacture of railway fittings. 3200 w. Engng. Feb. 17, 1899. No. 26218 A.

Shop Practice.

Electrical Shop Practice. B. F.

Fells. Calls attention to slight repairs often needed in running electrical machinery. Ill. 1200 w. W Elect'n—Feb. 25, 1899. No. 26270.

Some Points of Practice Seen in the Shops of the Cincinnati Milling Machine Co. F. J. M. Describes an index worm-wheel testing machine, an arrangement of overhead rail for lathes, arrangement of rail and hoist for drill-presses, graduating machine, and machine for marking figures. Ill. 2500 w. Am Mach—March 16, 1899. No. 26550.

Shop Costs.

Dèpreciation as an Element of Machine-Shop Cost-Keeping. H. M. Norris. A discussion of the relation of depreciation to general expense, showing the various methods adopted in writing off plant and the use of cost diagrams. 4500 w. Engineering Magazine—April, 1899. No. 26820 B.

Slot Machines.

Coin-Controlled Machinery. Arthur F. Wines. Describes a device of the writer's invention which is intended for use in connection with automatic telephones, but applicable to other machines. Ill. 1500 w. Sib Jour of Engng—March, 1899. No. 26620 C.

Tool.

Turret Forming Tool. H. Goldsmith. Illustrates and describes this tool, considers why so called, and the variety of work to which it is applied. 800 w. Mach, N. Y.—March, 1899. No. 26284.

Tubing.

The Production of Ribbed Tubes and Poles. (Herstellung von Rippenrohren und Rohrmasten.) Otto Klatte. Describing a method of rolling seamless ribbed tubing from the ingot, for use as trolley poles, etc. 2000 w. Stahl und Eisen—March 1, 1899. No. 26740 D.

Wages.

Wages and Production. Arthur A. Fuller. A discussion of co-operative plans and their effect upon production. 2000 w. Mach, N. Y.—March, 1899. No. 26288.

Watch Industry.

The Building of a Watch. Illustrates and describes the construction and adjustment of the machine-made watch, as carried out at the Waltham Watch Factory. 4000 w. Sci Am—March 4, 1899. No. 26289.

Wheels.

How Metal Wheels Are Made. B. F. Spalding. On the increased use of metal wheels, their strength, durability and cheapness, with information concerning them. 2200 w. Am Mach—March 16, 1899. No. 26,551.

Wood-Working Machinery.

The Development of Woodworking Machinery. John Richards. Mr. Richards's

third paper discusses the special features of European sawing machinery, including gang saws, band saw mills and various forms of saw benches. 3500 w. *Engineering Magazine*—April, 1899. No. 26821 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. Mr. Orcutt's fourth paper discusses the differences in commercial methods and sales management between European and American establishments. 3500 w. *Engineering Magazine*—April, 1899. No. 26816 B.

MATERIALS OF CONSTRUCTION.

Alloys.

The Influence of Temperature on the Properties of Alloys. (Etude sur l'Influence de la Température sur les Propriétés des Alliages Métalliques.) M. G. Charpy. A very complete investigation of the effect of increased temperature upon the strength of alloys, with especial reference to various bronzes and copper alloys. 12000 w. *Bull de la Société d'Encour*—Feb., 1899. No. 26737 G.

Boiler Material.

Recent Advances in the Manufacture of High-Grade Boiler and Pipe Material. On the continual and rapid progress in materials, made necessary by increase of pressures. Ill. 5500 w. *Jour Am Soc of Naval Eng*s—Feb., 1899. No. 26490 H.

Testing.

First Results of the A. F. A. Tests. A memorandum, from Dr. Richard Mollenke, chairman of the committee, relative to the first series of test bars and the results of the physical tests. Tables. 1000 w. *Ir Trd Rev*—March 9, 1899. No. 26439.

Testing Machines. F. A. Riehle. Read before the Foundrymen's Assn., at Philadelphia. Information concerning the extent to which testing of materials is now carried, and the use of testing machines. 3300 w. *Ir Trd Rev*—March 9, 1899. No. 26437.

The International Association for Testing Materials. Gus. C. Henning. A review of the origin and work of this important organization, showing its important relation, both to the manufacturing and the export engineering trades. 4000 w. *Engineering Magazine*—April, 1899. No. 26824 B.

POWER AND TRANSMISSION.

Dynamometer.

A New Hydraulic Dynamometer. (Nouveau Système de Dynamomètre à Pression Hydraulique.) The pressure on a thrust bearing or on the driving arms of a revolving coupling is transmitted hydraulically to a pressure gauge, enabling the force to be measured. 1200 w. *Génie Civil*—Feb. 18, 1899. No. 26703 D.

Horse-Power.

The Measure of Horse-Power. Considers various arithmetical equivalents of the unit of measure known as a horse-power. 2200 w. *Engr, Lond*—March 10, 1899. No. 26599 A.

Metering.

Metering Compressed Air. F. Schmerber. On the method of determining the amount of compressed air used, meters, tables of multipliers to be used for transforming volumes of compressed air at various pressures into corresponding volumes of free air at atmospheric pressure, etc. 1500 w. *Compressed Air*—March, 1899. No. 26460.

Power Gas.

The Riché Gas Producer. (Le Gazo-gène Riché.) An illustrated description of the Riché apparatus, by which an excellent fuel and power gas is produced in connection with the distillation of wood. 2000 w. *Génie Civil*—Feb. 11, 1899. No. 26701 D.

Lean Gas and the Riché Process. (Gaz Pauvre et Gaz Riché.) A comparison between the cost and value of producer gas and the gas produced by the distillation of wood by the Riché process. 1800 w. *L'Electricien*—March 18, 1899. No. 26778 B.

Power Plant.

Mechanical Plant of the Boston Southern Terminal Station. Illustrated description of a large plant for electric and refrigerating purposes, containing many novel features. 4200 w. *Eng Rec*—March 18, 1899. No. 26574.

Rope Driving.

Ropes for Power Transmission. Discusses the different materials used, the three and four strand ropes, and a new form of square rope. 2000 w. *Mach, N. Y.*—March, 1899. No. 26286.

Tool Driving.

The Horse-Power of Machine Tools. C. H. Benjamin. A summary of the results of many tests to determine the power required to drive machine tools and shafting. 1500 w. *Mach, N. Y.*—March, 1899. No. 26285.

SPECIAL MOTORS.

Gas Engines.

Gas-Engines as Motive Power in Engineering Works. A. R. Bellamy. Abstract of paper read at meeting of the Manchester Assn. of Eng's. A discussion of the cost and some information concerning the methods adopted. Discussion. 3300 w. *Jour Gas Lgt*—March 14, 1899. No. 26692 A.

Some recent Developments in the Gas Engine Field. Edwin Ruud. Abstract of a paper read before the Technische Ve-

rein, Pittsburg. A talk on the advantages and disadvantages of the two classes most largely used, the gas consumption, water consumption, and the future outlook. Ill. 2300 w. Elec Eng, N. Y.—March 2, 1899. No. 26317.

Petroleum Engine.

The Capitaine Petroleum Engine. From *Zeitschrift des Vereins Deutscher Ingenieure*. Illustrates and describes an oil engine especially designed with the view of meeting the requirements for isolated small powers. 2800 w. Ir Age—March 9, 1899. No. 26423.

The Improved Daimler Motor Vehicles. (Ueber Neure Motorwagen der Daimler Motoren-Gesellschaft.) K. Hallbauer. With numerous illustrations of the application of this compact and convenient petroleum motor to launches, carriages, and heavy vehicles. 1800 w. Glaser's Annalen—March 1, 1899. No. 26735 D.

STEAM ENGINEERING.

Boiler Coverings.

Tests of Locomotive Boiler Coverings. George R. Wallace. A letter commenting on Mr. Quayle's paper which reported tests of locomotive laggings, and indicating the value of the commercial coverings. 1400 w. R R Gaz—March 10, 1899. No. 26451.

Boiler Settings.

The Importance of Proper Boiler Settings in Water-Gas Plants. Jno. R. Lynn. Read at meeting of the Michigan Gas Assn. Notes defects and discusses rules, and fuel tests. 2200 w. Pro Age—March 1, 1899. No. 26321.

Compression.

Compression in Steam Engines (La Compression dans les Machines à Vapeur.) Bryan Donkin. A discussion of the experiments of Prof. Dwelshauvers-Dery in comparison with those made in other countries. 2000 w. Revue de Mécanique—Feb., 1899. No. 26788 H.

Condensers.

Condensing Arrangements at Collieries. Hugh Bramwell. Read before the South Wales Inst. of Engs. Classifies the conditions usually existing, discussing each and the particulars of the work. 2800 w. Col Guard—March 17, 1899. No. 26809 A.

Cylinder Ratios.

Cylinder Ratios for Compound Engines. George I. Rockwood. Condensed from a paper read before the Providence Assn. of Mech. Engs. The views of the writer on the design of compound engines, giving them far larger cylinder ratios, with lengthy editorial discussion. 3800 w. Eng News—March 2, 1899. No. 26344.

Exhaust Steam.

"Regenerating" Exhaust Steam. A criticism of an apparatus recently patented by Hugh J. Barron, which it claims is "a

worthless patent for a worse than worthless device." 2300 w. Eng News—March 2, 1899. No. 26343.

Utilization of Exhaust Steam. J. H. Harding. Paper read at convention of the Northwestern Elec. Assn., with discussion. Reports satisfactory heating by the Yaryan system, at La Porte, Ind. 6000 w. Elec, N Y—March 8, 1899. No. 26430.

Explosion.

A Remarkable Boiler Explosion. Illustrates and describes the explosion of the shell of a Scotch boiler on the steamer Francis Joseph I., at Prague, Austria, on the morning of May 19, 1898. 1100 w. Engr, Lond—Feb. 17, 1899. No. 26215 A.

Steam Boiler Explosion at Splitter near Tilsit. (Dampfkessel-explosion in Splitter bei Tilsit.) The official report of a disastrous explosion, with photographs showing the nature and extent of the damage. 2000 w. Zeit d ver Deutscher Ing—March 11, 1899. No. 26729 D.

Feed Water.

Purification of Water for Use in Steam Boilers. James Otis Handy. Considers the troubles due to corrosion, scale formation and foaming; the analysis of the water, and the methods; changes occurring in water in boilers; changes occurred as purifiers; various processes, etc. 10500 w. Pro of Engs' Soc of W Penna—Jan., 1899. No. 26462 D.

Flow.

On the Flow of Steam Through Pipes. A discussion of this problem, with tables. 3000 w. Locomotive—Feb., 1899. No. 26524.

Four-Crank Engines.

Examples of Four-Crank Engines, and Their Auxiliaries. John Thom. Read before the Inst. of Engs. & Shipbuilders in Scotland. Illustrates and describes the principal features. 1800 w. Engs' Gaz—March, 1899. No. 26428 A.

Fuel.

Liquid Fuel. Sir Marcus Samuel. Briefly considers the nature of petroleum, and the conditions in the production and transportation; the advantages in using it as compared with coal. Discussion. 7000 w. Jour Soc of Arts—March 17, 1899. No. 26690 A.

Inventions.

Needed Inventions. Robert Grimshaw. The present article gives general remarks on the subject, and represents the need of a good accumulator or storage battery. 1700 w. Mod Mach—Feb., 1899. Serial. 1st part. No. 25888.

Lubrication.

Concerning Cylinder Oil. W. H. Wakeman. Some points on the quality and quantity of oil to secure the best re-

sults. 1200 w. *Am Mach*—March 9, 1899. No. 26422.

Marine Engines.

See *Marine Engineering*.

Mechanical Draft.

The Efficiency of Fuel with Mechanical Draft. Walter B. Snow. Points out the economy secured and possible quantitative advantages. 1500 w. *Power*—March, 1899. No. 26298.

Pumping Engines.

See *Municipal Engineering, Water Supply*.

Pumps.

Steam Pumps. J. C. Smith. A discussion of direct-acting pumps, in which the pressure on the steam piston is transmitted through the piston-rod to the water-piston direct, without the intervention of a crank, fly-wheel, or any rotating piece. 4500 w. *Engr, U. S. A.*—March 1, 1899. No. 26409.

Tests Upon Steam Pumps and Injectors. A collection of valuable data upon pumps of different styles and sizes. H. E. Walton and William Wallace Christie. 1200 w. *Mach, N. Y.*—March, 1899. No. 26283.

Smoke Prevention.

Internal Combustion Motors and the Prevention of Smoke in Cities. (*Verbrennungskraft Maschinen und die Rauchbelästigung der Städte.*) Joh Körting. Setting forth the important aid the general introduction of gas and petroleum motors would give to the abatement of the smoke nuisance. 4000 w. *Zeit d Ver Deutscher Ing*—Feb. 25, 1899. No. 26723 D.

The Smoke Nuisance in Its Legal Aspect. Gives a summary of the existing law in England, reviewing certain Acts of Parliament and some of the more important cases which have been decided. 4300 w. *Engng*—March 10 1899. No. 26596 A.

Steam.

Steam. W. E. McKay. Read before the New England Assn. of Gas Eng. On the cheap generation of steam. Discussion. 2000 w. *Am Gas Lgt Jour*—March 13 1899. No. 26503.

Steam Consumption.

The Calculation of Steam Consumption from the Indicator Card. Explains the manner of making the calculations. 1000 w. *Prac Engr*—March 3, 1899. No. 26511 A.

Steam Mains.

Steam Mains for Electric Supply Stations. R. Summerfield. Discusses the general arrangement, material, joints, expansion, pipe covering, etc. Ill. 1800 w. *Engng*—March 10, 1899. No. 26595 A.

Supporting Boilers.

On Hooks for Supporting Boilers. Discusses the hooks and their form, giving tabulated statements of safe dead loads for wrought-iron hooks of two forms. 2000 w. *Locomotive*—Jan., 1899. No. 26145.

Thermal Efficiency.

Comparative Thermal Efficiency of Steam Engines and Diesel Motors. E. D. Meier. The comparison given shows that the Diesel motor has in actual practice far outstripped the theoretical possibilities of the steam engine. Ill. 1800 w. *Sib Jour of Engng*—March, 1899. No. 26619 C.

Thermodynamics.

A study of the Steam Engine. (*Die Beurteilung der Dampfmaschine.*) E. Meyer. A discussion of the thermodynamic cycles of the steam engine considered in respect to the possible efficiency to be attained in practice. 2500 w. *Zeit d Ver Deutscher Ing*—Feb. 11, 1899. No. 26721 D.

Turbines.

Steam Turbines. Rankin Kennedy. Part first considers the turbine from its historical point of view, especially during the past fifty years, and also its construction. 1600 w. *Elec Rev, Lond*—Feb. 17, 1899. Serial. 1st part. No. 26230 A.

Valve Motions.

The Study of Valve Motions from Diagrams. J. C. Smith. Illustrates and describes the diagram of Prof. Zeuner reduced to a solution easily understood. 2200 w. *Engr, U. S. A.*—March 15, 1899. No. 26624.

Water-Tubes.

Water-Tube Boilers. Abstracts of two papers read before the Inst. of Civ. Engs., England, with editorial facts concerning the construction of the various types, and interesting points relating to the working, durability, economy, etc. 3300 w. *Engr, Lond*—March 17, 1899. No. 26808 A.

MISCELLANY.

Address.

A Few Phases in the Rise and Development of the Science of Mechanics. L. Y. Schermerhorn. A summary of the advances of mechanics. 7200 w. Prof. of Eng's Club of Phila—March, 1899. No. 26621 D.

Balloons.

The Balloon as an Instrument of Scientific Research. John M. Bacon. Showing the possibilities of the balloon for investigation. Discussion. 5400 w. *Jour Soc of Arts*—Feb. 17, 1899. No. 26261 A.

Competition.

America and Germany as Export Competitors and Customers. Louis S. Magee.

Mr. Magee's third paper describes German commercial and industrial methods, and shows the valuable suggestions and conclusions which may be drawn from them. 3000 w. Engineering Magazine—April, 1899. No. 26823 B.

Drawing Instruments.

The Choice and Care of Drawing Instruments. V. T. Wilson. Aims to aid beginners in the choice of tools, and the care needed in handling. 2800 w. Sib Jour of Engng—March, 1899. No. 26621 C.

Enameling.

Enameling as an Industry. Josef Vollkommer. The subject of enameling metals is considered. 2400 w. Ir Age—March 23, 1899. No. 26667.

Engineering Meetings.

Junior Meetings of Engineering Societies. A statement of their importance to young engineers. 900 w. Eng Rec—March 18, 1899. No. 26571.

Explosions.

Explosions Caused by Commonly Occurring Substances. Charles E. Munroe. Address before the Am. Chem. Soc. An interesting study of this class of explosions—as from dust, liquids, vapors, gases, etc., giving many examples. 15800 w. Science—March 10, 1899. No. 26461.

Fans.

See Architectural Engineering, Ventilation.

Friction.

The Molecular Theory of Friction between Polished Solids. (Théorie Moléculaire du Frottement des Solides Polés.) Marcel Brillouin. A brief paper before the French Academy, treating of friction in connection with the molecular theory of work and heat. 1000 w. Comptes Rendus—Feb. 6, 1899. No. 26743 D.

Iron Protection.

See Civil Engineering, Miscellany.

Labor-Saving Machinery.

Attitude of Workmen Toward Labor-Saving Machinery. On the unjust and cruel treatment of inventors of such machines in early times, and the opposition that still exists, although it is clearly shown that they are a benefit to the workmen. 1500 w. Bos Jour of Com—March 11, 1899. No. 26502.

Mechanics.

Familiar Subjects in Mechanics. Samuel Webber. Part first deals with step or cone pulleys. 1400 w. Mach, N. Y.—March, 1899. Serial 1st part. No. 26287.

MILITARY ENGINEERING

Armor.

Krupp Armor Plate. W. L. C. Two interesting communications to the U. S. Naval Committee from Captain O'Neil concerning development of the manufacture of armor plate, and advance in the Krupp-process. 3800 w. Ir Age—March 2, 1899. No. 26296.

Artillery.

The New Field Artillery. Discusses the transformations taking place. 3800 w. Jour U S Artillery—Nov.-Dec., 1898. No. 26,259 D.

Balloon.

The Visibility of Submarine Boats from Balloons. (Le Ballon Voit le Sous-Marin.) Leo Dex. Showing the availability of the captive balloon for the purpose of detecting the approach of a submarine boat, owing to the wider angle of vision. 2500 w. Revue Technique—March 10, 1899. No. 26720 D.

Battleship.

H. M. Battleship "Glory." Brief illustrated description. 700 w. Engng—March 17, 1899. No. 26804 A.

British Navy.

The Navy Estimates. Editorial discus-

sion of the British Navy estimates, and the circumstances which give them more than the usual interest. 3800 w. Engng—March 17, 1899. No. 26803 A.

Camps.

Hygienic Camps. H. R. Hopkins. Abstract of paper read at the meeting of the Medical Soc. of the State of New York. Discusses the approved appliances of civil life which may be adapted to camp life aiming to prevent disease, by giving clear soil, pure water and fresh air. 1500 w. San—March, 1899. No. 26354 D.

Cruiser.

The Japanese Armored Cruiser "Asama." Brief illustrated description of this twin-screw cruiser recently built. 500 w. Engng—March 3, 1899. No. 26521 A.

The New Cruiser for Japan. Illustrates and describes the "Chitose," the second of the cruisers built in the United States for the imperial navy of Japan. 600 w. Sci Am Sup—March 18, 1899. No. 26548.

Explosives.

Methods for the Examination of Explosives. W. J. Williams. An outline of the methods used for the examination of smokeless powders, as laid down by the regulations of the War Department and

practiced at Frankford Arsenal. Ill. 4500 w. Jour Fr Inst—March, 1899. No. 26-350 D.

Government Vessels.

Special Government Vessels. The Army Transport "Grant" and sister ships. William A. Fairburn. An account of the refitting of the vessels purchased of the Atlantic Transport Line. Ill. 4500 w. Marine Engng—March, 1899. No. 26334 C.

Gun Carriage.

Quick-Firing Field Gun Carriage. Illustrates and describes a field carriage, the characteristic feature consisting in the method of taking up the recoil. 900 w. Engr, Lond—March 10, 1899. No. 26,604 A.

Italian Navy.

Electricity in the Italian Navy. Giulio Martinez. The first of a series of articles aiming to give a description of the most recent applications of electricity; the description beginning with the generators. Ill. 1400 w. Elec Wld & Elec Eng—March 18, 1899. Serial. 1st part. No. 26584.

Light Artillery.

English Light Artillery. E. Rollin, in Revue d' Artillerie. A summary review of the evolution of the matériel. 1300 w. Jour U S Artillery—Nov.-Dec., 1898. No. 26258 D.

Machinery.

Machinery in Naval Warfare. (Le Macchine nella Guerra Navale.) A. Genardini. A very elaborate discussion of the fundamental importance of efficient and powerful machinery in modern naval warfare. Favourable mention is made of water-tube boilers and the steam turbine. 6000 w. Rivista Marittima—Feb., 1899. No. 26792 H.

Navy.

The Necessary Navy. (L'Armata Necessaria.) G. Astuto. A discussion of the conditions which indicate the degree of naval strength which should be possessed by a nation; with especial consideration of the position of Italy. 3500 w. Rivista Marittima—Jan., 1899. No. 26791 H.

Range Finder.

A Horizontal-Base Range and Position Finder for Coast Artillery. George O. Squier and Albert C. Crehore. Description and brief account of the development of the instrument. Ill. 3200 w. Jour U. S. Artillery—Nov.-Dec., 1898. No. 26257 D.

Santiago.

The Performance of Individual Ships at Santiago. Outlining the action of individual ships to determine how they fulfilled their parts. Ill. 2800 w. Engr, Lond—Feb. 24, 1899. No. 26372 A.

Smokeless Coal.

Coal for Naval Vessels. Reports a discussion following the introduction of an amendment to the Naval Bill appropriating \$20,000 to test the qualities of smokeless coal; gives reasons for the preference for bituminous coal. 2000 w. Marine March 9, 1899. No. 26470.

Submarine.

A Visit to the Goubet No. 2. (Une Visite au Goubet No. 2.) E. Duboc. An interesting description of this small submarine boat at Saint-Ouen, and a comparison with the Gustave Zédé. 2500 w. Le Yacht—Feb. 18, 1899. No. 26716 D.

Torpedo Boats.

On the Shape of Torpedo Boats. H. C. Vogt. Illustrates and describes a model, stating its desirable points. 1000 w. Steamship—March, 1899. No. 26509 A.

Torpedo Boat Practice. William W. Kimball. Suggestions as to the construction, repair and equipment. 2800 w. Marine Rev—March 2, 1899. No. 26322.

Turrets.

The Improved Turrets of the Battleship "Texas." Robert W. Henderson. Illustrates and describes the improvements instigated by Lieut. F. J. Haeseler, showing the method of loading the guns. 2200 w. Sci Am—April 1, 1899. No. 26827.

War Lessons.

The Lessons of the Spanish-American War. Editorial discussion of Admiral Colomb's paper. 3000 w. Engng—March 10, 1899. No. 26597 A.

Warships.

The Monitor, the Battle-ship, the Cruiser, and the Destroyer. G. W. Dickie. A critical discussion by the general manager of the Union Iron Works, of San Francisco, of the design and equipment of the several classes of war ships, from the viewpoint of the engineer and shipbuilder. 3500 w. Engineering Magazine—April, 1899. No. 26815 B.

Wire Guns.

New Type Wire Guns. Part first gives illustrated description of the service wire guns as given by the Royal Gun Factory. 1500 w. Engr, Lond—Feb. 24, 1899. Serial. 1st part. No. 26374 A.

MINING AND METALLURGY

COAL AND COKE.

Anthracite.

Anthracite Coal in Peru. William Grif-

fith. Reports concerning the topography and climate, geology, coal fields, etc. Maps and sections. 6000 w. Jour Fr Inst—March, 1899. No. 26352 D.

Coal Dust.

The Utilization of Coal Sludge and Coal Dust. From *Neues Saarbrueckener Gewerbeblatt*. Gives the principal features of the Bechem and Post system of water-spray firing and the results of trials. 900 w. Col Guard—March 17, 1899. No. 26810 A.

Coal Getting.

Across the Pitch versus Up the Pitch. O. E. S. Whiteside. Read before the Canadian Mining Inst. A comparison of the two methods. 1200 w. Can Min Rev—Feb. 28, 1899. No. 26304 B.

Coal Measures.

Fossil Plants of the Coal Measures as Stratigraphical Guides. Mark Stirrup. Abstract of paper read before the Manchester (Eng.) Geol. Soc. On the use that might be made of these plants as time marks. 1300 w. Col Guard—March 17, 1899. No. 26812 A.

Commentry.

Early Working in the Commentry Coal-field. M. Martinet. From a communication to the Société de l'Industrie Minérale. Describes the deposits and various phases of working. 3500 w. Col Guard—Feb. 24, 1899. No. 26364 A.

Cost Sheet.

A Colliery Cost Sheet. G. Johnson. Illustrations of bank and underground pay-bills are given, with remarks on the importance of the cost sheet. 1100 w. Col Guard—March 3, 1899. No. 26535 A.

Explosives.

Safety Explosives. Oscar Guttmann. From a paper read before the Soc. of Chem. Ind. Deals with the present state of knowledge and gives suggestions with regard to explosives for the purpose of blasting in coal mines where the presence of inflammable gas and coal dust constitute a danger. 4200 w. Col Guard—March 10, 1899. No. 26591 A.

Lignite.

Brown Coal Mining in the Rhineland. From a report by Dr. Niessen, British Vice-Consul at Cologne, describing the deposits and working of the mines. 900 w. Col Guard—March 10, 1899. No. 26592 A.

Natal.

Coal in Natal. Extracts from the report of a commission appointed to investigate the coal industry of Natal. 1200 w. U. S. Cons Repts. No. 379—March 21, 1899. No. 26607 D.

Oven.

A Description of the Semet-Solvay By-Product Coke-Oven Plant at Ensley, Alabama. William Hutton Blauvelt. Illustrates and describes a new plant recently put in operation, and compares the by-

product oven and its operation, with the beehive oven. 3500 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26243 D.

The Coking, in Beehive Ovens, of the Coals of the New River District, West Virginia. Charles Catlett. Gives observations made of the burning of a set of eight ovens by means of the draft-boxes, the observations extending over a period of about two weeks. 3000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26239 D.

Russia.

The Coal and Iron Resources of Russia. Part first gives particulars, hitherto unpublished, relating to the coal and mineral deposits of the Caucasus. 2200 w. Ir and Coal Trd Rev—Feb. 17, 1899. Serial. 1st part. No. 26210 A.

Siberian Coal.

The Vladivostok Coal Field in Siberia. Russell L. Dunn. Describes this field and the kinds and quality of coal found. Also the favorable transportation facilities. Ill. 1300 w. Eng and Min Jour—March 11, 1899. No. 26469.

Statistics.

The Coal and Iron Ore Mining Industries of the World. C. Le Neve Foster. From the general report for 1897 on mines and quarries. Statistics of all kinds of solid mineral fuel, and the working of the mines. 4000 w. Col Guard—March 10, 1899. No. 26590 A.

Washing Plant.

New Washing Plant at the Blanzly Colliery. M. Graillot. From a communication to the Burgundy section of the Société de l'Industrie Minérale. Gives particulars and illustrations of a new plant capable of washing 800 tons of coal in ten hours. 2600 w. Col Guard—March 3, 1899. No. 26534 A.

COPPER.**Deposits.**

The Copper Deposits of Person County, North Carolina, and Halifax County, Virginia. William B. Phillips. An account of what promises to be a good copper district. 900 w. Am Mfr and Ir Wld—March 17, 1899. No. 26569.

Mattes.

The Elimination of Impurities from Copper-Mattes in the Reverberatory and the converter. Edward Keller. Continued discussion of this paper. 3500 w. Trans Am Inst of Min Engs—Feb., 1898. No. 26252 D.

Prices.

The Position of Copper and Tin. Editorial on the rise in prices of these metals owing to growing consumption and limit of visible supplies. 1600 w. Engr, Lond—March 3, 1899. 26526 A.

South Africa.

The Moonta. A brief account of the discovery, deposits and value of this copper mine. 1000 w. Aust Min Stand—Feb. 9, 1899. No. 26505 B.

Supply.

Copper. The prices, production, supplies and consumption are discussed. 1600 w. Eng and Min Jour—March 11, 1899. No. 26466.

GOLD AND SILVER.**Alluvial Mining.**

Some Notes on Alluvial Mining in New Zealand. Jno. W. Gray. Notes taken mainly from information given in the Government report, showing unabated interest in alluvial mining. 1600 w. Min & Sci Pr—Feb. 25, 1899. No. 26341.

Beach Sands.

Gold-Bearing Beach Sands of California. Arthur Lakes. How they are formed, deposited, and concentrated by the waves of the ocean. 900 w. Mines & Min—March, 1899. No. 26392 C.

Colorado.

Prospecting Districts of Northern Colorado. Marshall D. Draper. Gives description and formation of some promising localities. Map. 3500 w. Min Rept—March 16, 1899. No. 26632.

Cyanide.

Wet-Crushing with Cyanide. Arthur H. Thorpe. A general description of the method followed with much success in one of the leading mills in New Zealand. 900 w. Aust Min Stand—Jan. 19, 1899. No. 26310 B.

Density-Rule.

A Prospectors' Density Rule. J. Holms Pollock. Illustrates and describes the device and its use. 900 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26240 D.

Denver Mint.

The Denver Mint. Thomas Tonge. The first coinage of gold there by a private firm in the early "sixties." Great increase in Colorado's annual gold production. The careful methods followed. Ill. 2800 w. Mines & Min—March, 1899. No. 26388 C.

Desilvering.

The Electrolytic Desilvering of Argentiferous Lead. (Désargentation Electrolytique des Plombs Argentifères.) A description of the Tommasi process. A solution of double acetate of lead and sodium is used, pure crystals of spongy lead being deposited on the cathode, the silver falling to the bottom of the tank. 1800 w. L'Electricien—March 4, 1899. No. 26775 B.

Dredging.

Dredging for Gold. Robert Norman

Bell. The construction of dredges which successfully work gravel which cannot be profitably handled by other means. 1600 w. Mines & Min—March, 1899. No. 26395 C.

Extraction.

Methods of Gold Extraction by Electrolysis. C. A. Mulholland. Part first notes the causes of wasted energy on useless contrivances and reviews the attempts made to introduce electrolysis into the process of amalgamation. 2500 w. Aust Min Stand—Jan. 12, 1899. Serial. 1st part. No. 26309 B.

Fuel.

Fuel at the Caylloma Mines, Peru. Information concerning the difficulty in obtaining fuel at this silver mine, and the various expedients. Ill. 1100 w. Ir & Coal Trds Rev—Feb. 24, 1899. No. 26378 A.

Gold Veins.

The Gold-Bearing veins of Bag Bay, Near Lake of the Woods. Peter Mackellar. Describes the geological formation, mining developments, vein characteristics and peculiarities. 4200 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26248 D.

Klondike.

A Journey to the Klondike (Eine Reise nach Klondyke.) Zdenko Horovsky. An excellent account of the methods of mining for gold in the Klondike region, being an address by a Bohemian engineer, relating his experiences. 3500 w. Zeit d Oesterr Ing u Arch Ver—March 3, 1899. No. 26733 B.

Losses.

Losses of Gold in Mill Water. A. von Gernet. Gives results of experiments and calls attention to sources of danger of cyanide contamination. 1100 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26440 E.

Mexico.

The Gold Resources of Mexico. V. R. de Cornely. Part first describes the auriferous veins and the progress of the gold mining industry. 2000 w. Eng & Min Jour. March 18, 1899. Serial. 1st part. No. 26585.

New Gold Districts.

The Discovery of New Gold Districts. H. M. Chance. Calls attention to valuable accidental discoveries, and to investigations which have led prospectors to decide that the only safe way is to assay everything. 2500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26244 D.

Nova Scotia.

Nova Scotia Gold Mines. George W. Stuart. On the changes in the system of mining and milling which have placed the business on a permanent basis. 1000 w. Eng & Min Jour—March 11, 1899. No. 26468.

Oregon.

Eastern Oregon Gold Belt. John F. Leland. Brief mention of a few of the active mines of this section showing a bright outlook. 900 w. Min Rept—March 9, 1899. No. 26506.

Placer Deposit.

A North Carolina Hydraulic Proposition. Illustrated description of the plant of the Irvindale Mining Co. 700 w. Eng & Min Jour—March 11, 1899. No. 26467.

Precipitation.

A Zinc Process for Precipitating Gold from Weak Solutions. T. L. Carter. Continued discussion of this paper. 5000 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26441 E.

Production.

Marvelous Increase in Production of Gold. Alexander E. Outerbridge, Jr. A study of the gold production of the world, the increase due to progress in mining and metallurgical arts, and facts of interest concerning this precious metal. 3200 w. Ap Pop Sci M—March, 1899. No. 26282 D.

Solutions.

The Theory of Solutions. A. von Oettingen. An outline of newly-discovered laws, and their application. 4000 w. Jour of Chem & Met Soc of S Africa—Jan., 1899. No. 26442 E.

Stamp Mills.

An Improved Method of Introducing Feed Water to the Stamp-Mill Mortar. Bernard MacDonald. Read before the Canadian Mining Inst. Claims an increase of crushing capacity, decrease of sliming, and perforation of the bottom of the mortar to retain and protect the coarse gold from abrasion. 1200 w. Can Min Rev—Feb. 28, 1899. No. 26303 B.

Notes on Steam and Other Stamps. C. H. Fitch. Summary of information from various sources showing the progress. 1800 w. Min & Sci Pr—March 4, 1899. No. 26498.

Utah Mines.

Bingham Canyon Mines. Don Maguire. A description of one of the oldest and still one of the richest mining camps of Utah. A history of the early discoveries of silver-lead ore and their development into great producers of lead, silver, gold and copper. 3000 w. Mines & Min—March, 1899. No. 26394 C.

West Africa.

The Gold Mines of West Africa. James Irvine. Brief sketch of the history of this coast showing the richness in gold, and giving information concerning the climate, and conditions of the country. Also discussion. 7000 w. Jour Soc of Arts—Feb. 24, 1899. No. 26385 A.

IRON AND STEEL.**Cast Iron.**

See Mechanical Engineering, Machine Works and Foundries.

Chemistry.

The Relation of Chemical Composition and Microscopic Structure to the Physical Properties of Iron and Steel. (Zusammenhang der Chemischen Zusammensetzung und des Mikroskopschen Gefüges mit den physikalischen Eigenschaften von Eisen und Stahl.) Hanns Freiherr von Jüptner. An important paper by the leading authority in Germany, giving the latest information on these much discussed points. Two papers, 5000 w. Stahl und Eisen—March 1, 15, 1899. No. 26741 each D.

Chilled Rolls.

Chilled Rolls, and Why They Break. E. D. Nicholson. The analysis of iron for making rolls is considered and the causes of breakage discussed. 4400 w. Ir & Coal Trd Rev—Feb. 17, 1899. No. 26211 A.

Costs.

A Decade of Progress in Reducing Costs. C. Kirchhoff. Presidential address before the Am. Inst. of Min. Engs. Notes discoveries and improvements in practice and equipment which have contributed to progress in reducing costs, showing the effect on pig iron, Bessemer ingots, rolling rods, and lead smelting. 3700 w. Ir. Age—March 2, 1899. No. 26295.

Hardening.

Early Methods of Hardening Steel. (Stahlhärten in Früheren Zeiten.) Otto Vogel. A contribution to the history of iron, showing the development of the present knowledge from the earliest times. 3000 w. Stahl und Eisen—March 1, 1899. No. 26742 D.

Iron Ore.

The Cumberland Iron-Ore Deposits. W. Wilson Barnes. Considers the probability of new discoveries of hematite iron-ore, and things necessary to secure prosperity for the British iron and steel industry. 2000 w. Ir & St Trds Jour—Feb. 18, 1899. No. 26279 A.

Iron Tract.

The Rich Patch Iron Tract, Virginia. H. M. Chance. Describes the location, topography, geology, ores, mining development, and methods. Ill. 3500 w. Trans Am Inst of Min Engs—Feb., 1899. No. 26241 D.

Kytchtym Medal.

The Kytchtym Medal. Dr. Persifor Frazer. Discussion of paper presented at the meeting of Dec., 1897. Ill. 1200 w. Trans Am Inst of Min Engs—Oct., 1898. No. 26254 D.

Limonites.

The Limonites and Their Use in the Blast Furnace. J. C. Foster. Considers these ores and the manner of treating them, the plan of buying the ores on the basis of analysis, the objections to them, etc. 1200 w. Am Mfr & Ir Wld—March 17, 1899. No. 26568.

Manganese.

Manganese in the Acid Open-Hearth Process. F. A. Matthewman. Abstract of a paper read before the West of Scotland Ir and Steel Inst. Presents the principal effects of manganese in this process, the statements being founded on practical observations. 2700 w. Ir & Coal Trds Rev—March 17, 1899. No. 26806 A.

Production.

British Production of Steel in 1898. Statistics showing a decrease on the previous year. 800 w. Col Guard—March 17, 1899. No. 26811 A.

Rolling Mill.

A Modern Sheet Bar Mill. Describes the bar mill of the National Steel Co.'s Shenango Valley plant, at New Castle, Pa. 1500 w. Ir Trd Rev—March 9, 1899. No. 26438.

Rolls.

The Design of Roughing Rolls. William Hirst. Considers improvements and economy in roll turning, discussing the gothic, the diamond, and the box pass, and the classes of work for which they are adapted. 6200 w. Ir Age—March 16, 1899. No. 26537.

Swedish Iron.

Swedish Iron Metallurgy and Its Application to Canada. James Douglas. Read before the Canadian Mining Inst. Compares the similar conditions of Canada and Sweden, and shows how the former country may learn from the latter. 4800 w. Can Min Rev—Feb. 28, 1899. No. 26306 B.

Tuyeres.

Tuyeres in the Iron Blast Furnace. Contributions to the discussion of this subject by B. F. Fackenthal, Jr., John M. Hartman, R. W. Raymond and others. Ill. 11000 w. Trans Am Inst of Min Eng—Oct., 1898. No. 26245 D.

Valves.

Hot-Blast Valves. James Robinson. Read before the West of Scotland Iron and Steel Inst. A record of the hot-blast valves the writer has had in use, their working, design, defects, alterations, and improvements. Ill. 1800 w. Ir & Coal Trd Rev—Feb. 17, 1899. No. 26208 A.

MINING.**Ancient Rivers.**

Mysteries of the Ancient Rivers of the Forest Hill Divide, Placer Co., Cal. An

account of the discovery of what is presumed to be a continuation of the rich channel worked in former years in the Dix mine, with information concerning these channels. Ill. 1500 w. Min & Sci Pr—March 18, 1899. No. 26646.

Explosives.

Safety Explosives for Gaseous Mines. (Ueber Sicherheitssprengstoffe für Schlagwettergruben.) A critical comparison of the various safety explosives used in Germany, in connection with the possible ignition of fire damp. 2500 w. Oesterr Zeitschr f Berg u Hüttenwesen—March 4, 1899. No. 26754 B.

The Testing of Explosives for Mining Purposes. A report by Major A. Cooper-Key to the chief inspector of explosives on the working of the Home Office Testing Station for the year 1898. 4500 w. Col Guard—Feb. 24, 1899. No. 26360 A.

Fan.

The Patton Fan. Ernest Brackett. The methods used in calculating its proportions and some particulars of tests of its efficiency. Ill. 2800 w. Mines & Min—March, 1899. No. 26393 C.

Fire Damp.

Report of the Committee for the Investigation of the Firedamp Question. (Mitteilungen der Ständigen Comités zur Untersuchung von Schlagwetterfragen.) Giving the results of the work of the Austrian commission, with especial reference to safety primers, explosives, and lamps. 3000 w. Glückauf—Feb. 11, 1899. No. 26750 B.

Hoisting.

A Remarkable Hoisting Engine. Geo. S. Binckley. Describes an engine at the Bell mine, one of the properties of the Anaconda Copper Co., and its operation. 2500 w. Min & Sci Pr—Feb. 25, 1899. No. 26340.

Machine Mining.

Machine Mining of Bituminous Coal. William Edwin Hall. A review of the machinery used, and its effect on the capacity of production, and health and safety of the miners. 1800 w. Yale Sci M—Feb., 1899. No. 26256 C.

Mine Signaling.

See Electrical Engineering, Communication.

Mine Surveyors.

The Education of Mine Surveyors in Prussia. Bennett H. Brough. A summary of the regulations for the examination of mine surveyors recently adopted. 900 w. Col Guard—Feb. 17, 1899. No. 26225 A.

Mining Practice.

Notes on Michigan Mining Practice. W. L. Hildburgh. Notes on mine plants and methods of mining in the iron and

copper regions. 11300 w. Sch of Mines Quar—Jan., 1899. No. 26588 D.

Nova Scotia.

On the Proposed Revision of the Mines Act of Nova Scotia. Alex. McNeill. From *Proceedings* of Dec. meeting of the Mining Society of Nova Scotia. An examination of the proposed law, with general discussion. 6000 w. Can Min Rev—Feb. 28, 1899. No. 26301 B.

Shaft-Sinking.

Hoisting Device for the Sinking of the Emscher I shaft. (Fördereinrichtung beim Abteufen des Schachtes Emscher I.) An auxiliary shaft, enclosed within the main shaft contained a special hoisting plant which enabled the sinking to proceed without the interruption of regular work. 800 w. 1 plate. Glückauf—March 11, 1899. No. 26752 B.

Sinking a Shaft at the Victor Colliery, Westphalia. From an article founded on papers by Herr Pieler and Herr Hennenbruch, in *Glückauf*. Illustrates and describes a difficult work. 5700 w. Col Guard—Feb. 17, 1899. No. 26227 A.

Sinking Deep Shafts by the Freezing Process. Abstract of a paper in the *Revue Universelle des Mines*. States the conditions to be observed. Ill. 1200 w. Eng & Min Jour—March 18, 1899. No. 26586.

Ventilation.

Compression Ventilators at the Schlesien and Deutschland Pits (Upper Silesia.) Bergassessor Steinhoff, *Zeitschrift für Berg-Hütten und Salinenwesen*. Illustrated description, with statement of advantages of this system. 2000 w. Col Guard—March 17, 1899. No. 26813 A.

Root Principles of Mine Ventilation. Points out some of the principles associated with the theory of heat, which should be understood by students of mine ventilation. 6000 w. Col Guard—Feb. 24, 1899. Serial. 1st part. No. 26363 A.

The Ventilation of the Schlesien and Deutschland Collieries by Blowers. Abstracted from article in *Zeitschrift für das Berg-Hütten-und Salinenwesen*. A description of the ventilation of two collieries by means of blowers placed underground. Ill. 1000 w. Ir & Coal Trds Jour—Feb. 24, 1899. Serial. 1st part. No. 26377 A.

MISCELLANY.

Alloys.

Alloys. William C. Roberts-Austen. Read before the British Inst. of Mech. Eng. The fifth report of the alloys research committee. Ill. 3000 w. Engng—Feb. 17, 1899. Serial. 1st part. No. 26220 A.

Note on the Disintegration of an Alloy of Nickel and Aluminum. Erwin S. Sper-

ry. Reports oft-repeated experiments showing an alteration in half-and-half alloy. 500 w. Trans Am Inst of Min Eng—Feb., 1899. No. 26238 D.

Aluminum.

The Progress of Aluminum. A review of progress during the past two years in the manufacture and utilization of aluminum and its alloys. 4500 w. Engr, Lond—Feb. 17, 1899. No. 26213 A.

Chromite.

The Occurrence, Origin, and Chemical Composition of Chromite; with Especial Reference to the North Carolina Deposits. J. H. Pratt. A careful study of these deposits was made by the writer and he gives reasons why the chromite should be regarded as having been formed at the same time with the peridotites. 8000 w. Trans Am Inst of Min Eng—Feb., 1899. No. 26246 D.

Clay Deposits.

A Geologic and Economic Survey of the Clay-Deposits of the Lower Hudson River Valley. Clemens Catesby Jones. Gives an account of investigations made to determine in a practical manner the location, form and extent of all the clay-deposits at present existing in the lower Hudson River Valley, and to ascertain the quantity and suitability of a clay for the manufacture of common building bricks. Ill. 10500 w. Trans Am Inst of Min Eng—Feb., 1899. No. 26247 D.

Cornish Mines.

Cornish Mines and Cornish Miners. J. H. Collins. An interesting account of this district and the minerals found, with special review of the great tin and copper industries, the peculiarities of mining, the production, etc. Also discussion. 14600 w. Jour Soc Arts—March 10, 1899. No. 26614 A.

Corundum.

Corundum in Ontario. Archibald Blue. Gives an account of the first discovery and of later researches which proved the mineral to exist in Canada in commercial quantity. 5300 w. Trans Am Inst of Min Eng—Oct., 1898. No. 26249 D.

The Abrasive Efficiency of Corundum. W. H. Emerson. Discusses, I. The relation between the "effective hardness" of corundum and its content of water; II. Smith's test as a means of determining the abrasive efficiency of corundum. 6500 w. Trans Am Inst of Min Eng—Feb., 1899. No. 26242 D.

Diamonds.

The Occurrence and Origin of Diamonds in California. H. W. Turner. Reports concerning the occurrence and number of diamonds found, with discussion of the origin. 3000 w. Am Geol—March, 1899. No. 26431 D.

Electric Smelting.

See Electrical Engineering, Electro-chemistry.

Electro-Metallurgy.

See Electrical Engineering, Electro-chemistry.

Machinery.

Metallurgical Machinery. A. C. McCallum. Read before the Canadian Mining Inst. Deals with the most familiar machines used by miners, such as crushers, rolls, stamps, and feeders, from the designer's point of view. 4000 w. Can Min Rev—Feb. 28, 1899. No. 26305 B.

Mica.

Mica Mining in Bengal, India. A. Mervyn Smith. Read before the Institution of Mining and Metallurgy. Describes the mines and native methods of mining, also the present method of work. 2500 w. Col Guard—Feb. 24, 1899. No. 26362 A.

Natural Gas.

Natural Gas in Colorado. Arthur Lakes. Deals with the origin of natural gas and petroleum, and their relations to bituminous shale and asphaltum, describing the White River gas field. 2500 w. Mines & Min—March, 1899. No. 26389 C.

Platinum.

The Platinum Deposits of the Tura River System, Ural Mountains, Russia. C. W. Purington. Illustrates and describes the principal platinum-producing district of the world, its discovery, the value of the deposit, manner of working, etc. 4500 w. Trans Am Inst of Min Eng—Feb. 1899. No. 26250 D.

Porto Rico.

The Mineral Resources of Porto Rico. W. L. C. Abstract of the preliminar

report of Robert T. Hill, who has recently returned from a tour of investigation to determine the mineral resources. 1500 w. Ir Age—March 16, 1899. No. 26538.

Quicksilver.

New Almaden Mines of Santa Clara County, California. Arthur Lakes. These mines are the principal producers of quicksilver in the United States. Gives a description of their peculiar features, their geological formation, and a comparison of them with the older mines of Almaden in Spain. 3800 w. Mines & Min—March, 1899. No. 26390 C.

Standards.

Metallurgical Standards. Frederick T. Snyder. Read before the Canadian Mining Inst. Discusses the unit of weight, the scale of sizes for crushed ore, and a coefficient that shall represent the mechanical condition of the ore. 2200 w. Can Min Rev—Feb. 28, 1899. No. 26302 B.

Thermometry.

The Measurement of High Temperatures. T. H. Waller. Abstract of a paper read before the South Staffordshire Inst. of Iron and Steel Works Managers. Reviews the various methods, favoring the thermo-couple of platinum and rhodium platinum. 1600 w. Ir & Coal Trds Rev—March 17, 1899. No. 26805 A.

Vanadium.

See Electrical Engineering, Electro-chemistry.

Zinc.

A New Method for the Determination of Zinc. A. C. Laugmuir. Presented to the Am. Chem. Soc. Describes the phosphated method which is largely used in America. 1200 w. Ind & Ir—March 10, 1899. No. 26594 A.

MUNICIPAL ENGINEERING

GAS SUPPLY.

Acetylene.

Acetylene. A discussion of progress made with this illuminant, the researches made at Pintsch's gas works at Berlin and Fürstenwalde, trouble with the burners, etc. Ill. 3800 w. Engng—March 17, 1899. No. 26802 A.

Report of the Acetylene Exhibition Committee. A review of this report and statements concerning its value to those interested in the conditions of safety in acetylene generators. 1300 w. Engr. Lond—March 3, 1899. No. 26525 A.

The Conditions of Temperature Existing in Acetylene Generators. Results of experiments as given in report of Vivian B. Lewes. 4800 w. Jour Gas Lgt—March 7, 1899. No. 26552 A.

The Municipal Acetylene Plant at Oliva. (Die Acetylen Stadtanlagen in Oliva.) Dr. Paul Wolff. A description of a municipal plant for a small town in Eastern Prussia, with illustrations of the generating house and piping. 1800 w. Ill Zeitschr f Klein u Strassenbahnen—Jan. 16, 1899. No. 26786 D.

Address.

Inaugural Address before the Manchester District Institution of Gas Engineers. R. G. Shadbolt. Review of progress in the gas industry. 6000 w. Jour Gas Lgt—Feb. 28, 1899. No. 26426 A.

Inaugural Address before the Southern District Association of Gas Engineers and Managers. A. E. Broadberry. Discusses carburetted water gas and its use, and various troubles at Tottenham, with brief

references to matters of interest to the gas industry. 6200 w. Jour Gas Lgt—Feb. 14, 1899. No. 26207 A.

Analysis.

Analysis of Blast-Furnace Gas While Blowing In. Ralph H. Sweetser. Describes investigations made at Sparrow Point, Md. 1600 w. Trans Am Inst of Min Eng—Oct., 1899. No. 26251 D.

Modified Apparatus for Gas Analysis. E. Hönkus, in *Zeitschrift für Berg und Huttenwesen*. Illustrates and describes an apparatus designed by the writer, a modification of the Orsat apparatus, to enable hydrogen and gases of the C_nH_n series to be determined in the presence of carbon monoxide and methane in fire-damp and blast-furnace gases. 1400 w. Col Guard—March 3, 1899. No. 26533 A.

Combustion.

Recent Researches upon the Products of Combustion of Illuminating Gas. (Nouvelles Recherches sur les Produits de Combustion du Gaz d'Éclairage.) Dr. Grehant. An account of the latest investigations into the injurious products of burning gas, comparing various burners. 6000 w. Bull de la Société d'Encour—Feb., 1899. No. 26738 G.

Distribution.

Distributing Gas at Pressures Higher Than Usually Obtained with a Holder. B. J. Allen. Read at meeting of New England Assn. of Gas Engs. Describes the method used by the Brookline Gas Light Co. Discussion. 4300 w. Am Gas Lgt Jour—Feb. 27, 1899. No. 26273.

Enrichment.

Enrichment of Coal Gas. George H. Harper. A summary of what has been said and written on this subject. 2500 w. Gas Engs' Mag—Feb. 10, 1899. Serial. 1st part. No. 26234 A.

Gasholders.

Some Notes on the Construction of a Concrete Gasholder Tank. C. W. Andrews. Read at meeting of the Ohio Gas Light Assn. Describes the construction, which cost about two-thirds of what a similar brick tank would have cost. Discussion. 3000 w. Am Gas Lgt Jour—March 27, 1899. No. 26682.

The Action of Gasholder Cups. Considers the principles which govern their action. Part first discusses the approximate working conditions, general behavior of the water levels, action of cups when descending into tank, behavior of the gas entrapped in grip, and behavior of water-levels in grip. 1500 w. Gas Wld—Feb. 18, 1899. Serial. 1st part. No. 20-202 A.

Gas Plant.

Notes on the Design and Extension of Gas Plant. J. J. Humphreys, Jr. Read at meeting of New England Assn. of Gas

Engs. Calls attention to facts of importance in planning works. 4200 w. Am Gas Lgt Jour—Feb. 27, 1899. Serial. 1st part. No. 26274.

Lighting Apparatus.

The Auto-Lux from *La Nature*. Illustrated description of an apparatus for lighting and extinguishing gas at a distance. 700 w. Sci Am Sup—March 11, 1899. No. 26436.

Main Laying.

A Few Practical Notes on Main Laying. Lester Price. Considers material for street mains, distribution, pipe laying, lead joints, back filling, etc. 2000 w. Am Gas Light Jour—March 20, 1899. No. 26629.

Mantle.

A New Incandescent Gas Mantle. Information concerning the invention of William Lawrence Voelker, of Elizabeth, New Jersey. 2000 w. Jour Gas Lgt—Feb. 14, 1899. No. 26206 A.

The "Jasper" Incandescent Gas Mantle. Gives information concerning a mantle in demand in Germany, but not widely known elsewhere, with tests of its durability and report of its appearance. 1300 w. Jour Gas Lgt—March 14, 1899. No. 26691 A.

Naphthalene.

The Naphthalene Question. Dr. P. Eitner. Abstract translation of a paper read before the Mid-Rhemish Assn. of Gas and Water Engs., with editorial. A valuable contribution to the solution of this question. 4600 w. Jour Gas Lgt—Feb. 21, 1899. No. 26312 A.

Nuisance.

The Nuisance Question in Gas Works. Frederick H. Shelton. Read at meeting of New England Assn. of Gas. Engs. Discusses what constitutes a nuisance, and precautions that will avoid grounds for complaint. Also discussion. 3800 w. Am Gas Lgt Jour—March 6, 1899. No. 26396.

Water Gas.

A Beginner's Experiments in Studying the Operation of a Lowe Water-Gas Apparatus. J. B. Polk. Read before the New England Assn. of Gas Engs. A report of experiments made by the writer. 3000 w. Am Gas Lgt Jour—March 13, 1899. No. 26504.

Carburetted Water Gas. The Home Office report, with appendices treating of the subject under inquiry, concerning the extent of the manufacture, the danger, and the regulations necessary. 7800 w. Gas Wld—Feb. 18, 1899. No. 26203 A.

Home Office Inquiry into the Supply of Water-Gas. Text of the unanimous report of the Departmental Committee, with editorial comment. 32700 w. Jour Gas Lgt—Feb. 21, 1899. No. 26311 A.

Innovation in and Future of the Water-Gas Industry. Adapted and translated from a paper read by H. Croissant, at a meeting of the Mid-Rhenish Assn. of Gas and Water Eng's. Reviews briefly the differences of the two methods of producing gas from coals; describes the Dellwick and Strache generators, and gives interesting information in part first. 2500 w. *An Gas Lgt Jour*—March 20, 1899. Serial. 1st part. No. 26628.

SEWERAGE.

Filtration.

Notes on the Operation of the Sewage Filter. Beds of Plainfield, N.J. An account of the operation of this intermittent filtration system which has been in use three years. Ill. 1000 w. *Eng News*—March 16, 1899. No. 26553.

Havana.

Sewerage of Havana. Part first gives a statement of the present conditions. 700 w. *Fire and Water*—Feb. 25, 1899. Serial 1st part. No. 26272.

Rain Precipitation.

Tables of Excessive Precipitations of Rain at Chicago, Ill., from 1889 to 1897 Inclusive. Edwin Duryea, Jr. Facts considered important as data for sewerage engineers in proportioning the sizes of sewers for the removal of rainfall. 4000 w. *Tables. Jour of Soc of Eng's*—Feb., 1899. No. 26833 D.

River Pollution.

I. Report of the New Jersey River-Pollution Commission. II. An Important Decision on River Pollution by Sewage in New Jersey. Gives that portion of the report which refers to the condition of the lower Passaic River, in the first article. The second gives an important decision rendered by the Chancery Court of New Jersey. 3300 w. *Eng News*. March 9, 1899. No. 26449.

The Pollution of the Passaic River. Review of two decisions restraining the cities of Paterson and Newark from discharging sewage into a large stream. 700 w. *Eng Rec*—March 18, 1899. No. 26573.

Sanitation.

Perfect Sewerage and Perfect Health. G. M. Sinclair. Read before the Nat. Assn of Master Plumbers. Shows that good sewerage lessens the death rate, discusses sewerage systems and the disposal of sewage. 1800 w. *Met Work*—March 18, 1899. No. 26587.

Sewage Disposal.

A Hospital Sewage Disposal System. Illustrated description of the combined chemical treatment and filtration system installed at the Southern Hospital for the Insane, Evansville, Ind. 700 w. *Eng Rec*—March 11, 1899. No. 26477.

Bacillite Sewage Disposal at Hanley, England. Describes a unique system of

chemical treatment. 800 w. *Eng Rec*—March 25, 1899. No. 26678.

Chemical Sewage Treatment, Brooklyn, N. Y. Illustrated description of works for treating about 5,000,000 gals. of sewage daily by the Powers patented process. 800 w. *Eng Rec*—March 25, 1899. No. 26674.

Some Methods of Sewage Disposals. W. M. Watson. Describes the methods employed in the sewage purification systems of the late George E. Waring and Jerome Deery. 2500 w. *Can Engr*—March, 1899. No. 26546.

The Exeter Septic Tank System. Reviews the explanation given by the designer, Donald Cameron, of the principles of the system and a statement of the results attained with the first permanent plant. 3500 w. *Eng Rec*—March 25, 1899. No. 26675.

Sewerage Project.

The New Massachusetts Metropolitan Sewerage Project. Explains the main features of a \$4,600,000 undertaking for the district south and west of Boston. 500 w. *Eng Rec*—March 18, 1899. No. 26572.

Sewers.

A New Form of Sewer Invert Block. Arthur N. Talbot. Read before the Illinois Soc. of Eng's. and Survs. A comparison of circular and egg-shaped sewers, with description of a new form of invert block for use with circular sewers. 900 w. *Munic Engng*—March, 1899. No. 26,329 C.

New Units in the Design of Sewers. A discussion of the methods used in determining the unusually large amount of sewage per capita, 300 gals., on which the design of the south metropolitan sewers of Massachusetts were based. 1100 w. *Eng Rec*—March 25, 1899. No. 26668.

Studies for a High-Level Gravity Sewer for Boston and Vicinity. From a report of the Metropolitan Sewerage Commission recommending a plan for a high-level gravity sewer for the Charles and Neponset River valleys, and figures in the quantity of sewerage, the effect upon the waters of the harbors, etc. Ill. 2300 w. *Eng News*—March 16, 1899. No. 26554.

The Maintenance of Catch-Basins and Sewers in Providence. An article based on the quarter-century of experience in such work of the present head of the sewer maintenance force in that city. 2600 w. *Eng Rec*—March 25, 1899. No. 26,670.

STREETS AND PAVEMENTS.

Asphalts.

The Relative Viscosity of Asphalts and Allied Bodies. A. W. Dow. From the report of the operations of the Engineering Department of the District of Columbia for the year 1898. Describes methods of testing. 2400 w. *Munic Engng*—March, 1899. No. 26330 C.

Curbing.

The Proper Curbing of Streets. Horace Andrews. Abstracts of a paper written for *City Government*. Considers the disturbing forces that tend to displace the curb and means of guarding against them. Discusses material used, setting, etc. 2400 w. Stone—March, 1899. No. 26683 C.

New Orleans.

History and Selection of Street Paving in the City of New Orleans. A. C. Bell. Gives George W. Cable's description of the site and origin of the city, and reviews the progress of street-paving. 5000 w. Jour Assn of Engng Soc's—Feb., 1899. No. 26835 C.

Paris.

The Pavements of Paris. Information concerning the street pavements, which consist of stone, macadam, asphalt and wood. 800 w. U S Cons Repts, No. 380—March 22, 1899. No. 26631 D.

Paving Brick.

A New Method of Testing Paving Brick. Paper of Mr. Jones' read before the Nat. Brick Mfrs. Assn. Describes a new method of testing, aiming to reproduce the blow of the horse's foot and the rolling wear of the wagon. 2000 w. Clay Rec—March 27, 1899. No. 26566.

Methods of Testing Paving Brick. Illustrated review by W. K. Hatt, of many different tests, which he interprets as indicating the rattler test to be the only important one. 3200 w. Eng Rec—March 4, 1899. No. 26401.

The Evolution of Paving Brick in the United States. H. A. Wheeler. Read before the Nat. Brick Mfrs. Assn. Relates early experiments with paving brick in various places, its improvement and growing use. 3000 w. Clay Rec—March 27, 1899. No. 26567.

Road Construction.

See Civil Engineering, Miscellany.

Street Grades.

Establishing of Street Grades. Charles P. Chase. Discusses present practice, its advantages and disadvantages. Ill. 5500 w. Jour W Soc of Eng's—Feb., 1899. No. 26834 D.

Street Grades and Cross Sections in Asphalt and Cement. A discussion of the paper by Robert P. Woods. 4400 w. Pro. Am Soc of Civ Eng's—March, 1899. No. 26664 E.

WATER SUPPLY.**Duty Trial.**

Duty Trial of a 30,000,000 Gallon Pump at Buffalo. Trial of a triple-expansion fly-wheel pump which gave a duty of 158.6 million foot-pounds per 1000 lbs. of dry steam. 600 w. Eng Rec—March 4, 1899. No. 26405.

Electrolysis.

Electrolysis of Cast-Iron Pipe. Harold P. Brown. An account of the condition of the pipes at Dayton, O., and the method of testing, with suggestions for protecting the mains. 3400 w. Dom Engng—March, 1899. No. 26634 C.

Filtration.

A Sand Filter-Plant. J. W. Ledoux. Full paper with discussion. Illustrated description of a plant constructed for the Berwyn Water Co., having a capacity of one and one-half million gallons per day. 4200 w. Pro of Eng's Club of Phila—March, 1899. No. 26623 D.

Sand Filtration of Public Water Supplies. R. S. Lea. Read before the Canadian Soc. of Civ. Eng's. Describes the circumstances under which water supplies become polluted, and the nature of the pollution; also the process of purifying the water in large quantities by sand filtration. 13500 w. Adv Proof—Jan. 19, 1899. No. 26483 D.

The Berwyn Sand-Filter. Illustrated description of a sand-filter plant of 1,500,000 gals. daily capacity, constructed to be operated in connection with a mechanical filter plant, to determine the relative advantages of the two for the given conditions. 1200 w. Eng Rec—March 11, 1899. No. 26476.

The Cincinnati Filtration Experiments. A review of experiments lasting about 8 months to determine the best method of filtering a river water carrying at times large quantities of fine silt. 5200 w. Eng Rec—March 11, 1899. No. 26475.

The Slow Sand Filtration Plant of the Berwyn, Pa., Water Co. J. W. Ledoux. Abstract of a paper read before the Eng's Club of Phila. Illustrates and describes a plant having a nominal capacity of 1,500,000 gals. per day. 1400 w. Eng News—March 9, 1899. No. 26446.

Ground Water.

The Level of Ground Water in Wells. (Grundwassenspiegel bei Brunnenanlagen.) Dr. Ph. Forchheimer. An examination of the effect of wells upon the level of subterranean water strata, especially in connection with the use of wells for extensive water supply. 2000 w. Zeit d Ver Deutscher Ing—Feb. 25, 1899. No. 26724 D.

High Service.

The New High-Service System, Lawrence, Mass. Illustrated description of works chiefly noteworthy for an enclosed standpipe, which is described in some detail. 1700 w. Eng. Rec—March 25, 1899. No. 26673.

London.

The Hydrography of the Wealden: A Possible Solution of the London Water Question. Edward F. Willoughby. The writer thinks that subsoil waters natural-

ly running to waste, may be found in sufficient quantity. 2600 w. San Rec—March 17, 1899. No. 26694 A.

New York.

Water Consumption in Greater New York. Francis L. Pruyn. Illustrated review of the available water from present sources, and the time it will take to exhaust them. 1500 w. Eng Rec—March 11, 1899. No. 26474.

Paris.

The Needs of the Water Supply of Paris. (Besoins de l'Alimentation d'Eau à Paris.) A comparison of the water supply of Paris with that of other cities, showing the necessity for an increased supply of pure water, and indicating the possible sources. 2500 w. Revue Technique—Feb. 25, 1899. No. 26713 D.

Philadelphia.

Bureau of Water, Philadelphia. Extracts from report of J. C. Trautwine, with comments. Ill. 1600 w. Fire & Water—Feb. 25, 1899. No. 26271.

Pollution.

Proposed State Legislation to Prevent Water Pollution. Editorial discussion of bills before different states. 3600 w. Eng News—March 16, 1899. No. 26555.

Pumping Engines.

A Comparison of Compound and Triple-Expansion Engines for Small Water-Works Plants. J. M. Betton. Illustrates and describes the design of the Standard Horizontal Triple-Expansion Engines, brought out by Henry R. Worthington, examining the results obtained by those now in use. 1600 w. Jour New Eng Water Wks Assn—March, 1899. No. 26688 E.

Improvement in Pumping Engines. F. F. Forbes. Reviews recent changes showing the marvelous growth in the use of engines of this class, and the results of tests. 1600 w. Jour New Eng Water Wks Assn—March, 1899. No. 26684 E.

Present Pumping Engine Practice of the Edward P. Allis Co. Compared with that of Twenty-five Years Ago. Irving H. Reynolds. An engineer's review of the causes that have brought about the great advance in economy and decrease in cost. Ill. 8800 w. Jour New Eng Water Wks Assn—March, 1899. No. 26686 E.

The Application of Gas, Gasoline and Oil Engines to Pumping Machinery. Freeman C. Coffin. Considers the general characteristics of these engines, tests, cost, etc. 3800 w. Jour New Eng Water Wks Assn—March, 1899. No. 26687 E.

The Latest Designs in Worthington Pumping Machinery. Comparing Them with the Practice of Twenty Years Ago. Charles C. Worthington. Describes the means by which the economic efficiency has been more than doubled, with but few changes in the principles of operation and details of construction. Ill. 2800 w. Jour

New Eng Water Wks Assn—March, 1899. No. 26689 E.

The Possibilities of Economy in Pumping Engines as Based on the Latest Accomplishments. George H. Barrus. An examination of trials during the past five years, with a view to showing what it is reasonable to expect of the duty of a pumping engine under the best obtainable conditions. 2200 w. Jour New Eng Water Wks Assn—March, 1899. No. 26685 E.

Pumping Plant.

Deep Well Pumping Plant at Waukesha, Wis. Describes the plant and gives results and tests. 2200 w. Fire & Water—March 18, 1899. No. 26625.

The New Rockford Pumping Plant. Illustrated description of a 7,000,000 gal. plant having centrifugal pumps at the bottom of a shaft and driven by ropes from vertical engines—March 18, 1899. No. 26577.

Pumps.

A New Deep Well Pump. Illustrated description of a new form of differential water end having unusually large valve areas. 5000 w. Eng Rec—March 4, 1899. No. 26404.

Purification.

Report of the Water Purification Experiments at Cincinnati, O. A summary of work which was concluded at Cincinnati in January. Advises the adoption of the American system of clarification and purification. 2500 w. Eng News—March 9, 1899. No. 26450.

The Problem of Water Purification for the City of Philadelphia. P. J. A. Maignen. Notes the increasing daily consumption of water, and the urgent need of filtration; describes a system of sand filtration and its efficiency. Discussion. 10800 w. Pro of Eng's Club of Phila—March, 1899. No. 26622 D.

River Waters.

The Clarification of River Waters. Allen Hazen. Considers how waters become turbid and the conditions which control it, with the measures which can be taken to remove the turbidity from water supplies. 7400 w. Jour Fr Inst—March, 1899. No. 26349 D.

Standpipe.

Standpipe failure at Murphysboro, Ill. Illustrated description of the complete failure of a standpipe, 145 ft. high and 15 ft. in diameter, 15 ins. out of plumb at the time of the accident. 700 w. Eng Rec—March 18, 1899. No. 26576.

Thawing.

Thawing Frozen Pipes by Electricity. An illustrated account of the methods followed in thawing pipes up to 6 in. in diameter. 1000 w. Eng Rec—March 11, 1899. No. 26473.

Electricity for Frozen Water Pipes. Describes a method of thawing pipes by electricity used successfully in several cities. 900 w. Eng Rec—March 4, 1899. No. 26397.

Watertown, Mass.

The Transfer of the Watertown Water-Works. Describes the amicable transfer of a plant from private to public ownership. 1700 w. Eng Rec—March 18, 1899. No. 26575.

Wellesley.

Additional Water Supply of Wellesley. Describes the work of construction so successfully carried out, which consisted of driven wells connected with a suction main, and of a covered reservoir. 1300 w. Fire & Water—March 25, 1899. No. 26680.

Wells.

How Wells May Be Driven. Brief history of artesian wells and methods of boring. 1500 w. Fire & Water—March 25, 1899. No. 26679.

York, Pa.

The Water-Works of York, Pa. A description of the remarkable works built at this place in which the water was pumped 40 feet higher than needed and the reservoirs were constructed so as to be little better than sieves. 2000 w. Eng Rec—March 25, 1899. No. 26672.

Yport, France.

The Water Supply of the City of Yport. (Distribution d'Eau de la Ville d'Yport.) An interesting account of the manner in which a pure water supply was obtained for a seaport town from springs by the seashore. 300 w. 1 plate. Génie Civil—Feb. 25, 1899. No. 26704 D.

MISCELLANY.

Destructors.

The Horsfall Destructor. Abstract of report of Lord Kelvin and Professor Barr upon the tests of the Horsfall refuse destructors at Edinburgh, Bradford and Oldham. 1500 w. Engr, Lond—March 17, 1899. No. 26911 A.

Discussion.

The Cost of Municipal Enterprise. Discussion of Dixon H. Davies' paper. 14000 w. Jour Soc of Arts—Feb. 17, 1899. No. 26260 A.

Municipal Undertakings.

Municipal Notes. A review of water-works, sewage disposal and garbage cremation undertakings during 1898, in several cities. 4200 w. Eng Rec—March 4, 1899. No. 26403.

Public Baths.

The Municipal Baths of Berlin. (Die Städt. Badeanstalten Berlins.) An abstract of the report for 1897-98, with an account of the construction, use and management. 2500 w. Gesundheits Ingenieur—March 15, 1899. No. 26246 B.

See Architectural Engineering, Plumbing.

Refuse.

The Utilization of City Refuse. W. F. Morse. Remarks on investigations made, with a description of the plant of the Boston City Refuse Disposal Station, are given in part first. 2400 w. San—March, 1899. Serial. 1st part. No. 26355 D.

Sanitation.

A Half-Century of Sanitation. William Paul Gerhard. Read at meeting of the Brooklyn Engs' Club. Considers the progress during the second half of the nineteenth century in public sanitation and applied sanitary science. 3400 w. Am Arch—Feb. 25, 1899. Serial. 1st part. No. 26267.

History and Progress of Sanitation of the City of Washington, and the Efforts of the Medical Profession in Relation Thereto. Samuel C. Busey. Address at meeting of the Washington Academy of Sciences. A résumé of the history of sanitation in this city, covering a period of 107 years. 4500 w. San—March, 1899. No. 26353 D.

Trading.

Municipal Trading. Editorial discussion of this subject as viewed in England, and of some of the difficulties in the distribution of profits and losses. 2200 w. Engr, Lond—March 10, 1899. No. 26,603 A.

Municipal Trading. The first of a series of articles discussing conditions in England which have led to the development of municipal trading, and the measure of success which has thus far attended the practice. 1800 w. Jour Gas Lgt—Feb. 28, 1899. Serial. 1st part. No. 26425.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in 1898. Tabulated summary of the year's accidents, with comments. 1000 w. R R Gaz—March 10, 1899. No. 26458.

Train Accidents in the United States in January. Detailed list with classified summary, and an editorial on "Emergency Single-Track Blocking," discussing the butting collision at West Dunellen, N. J. 3400 w. R R Gaz—March 24, 1899. No. 26655.

Japan.

Japanese Railways. C. Kadono. Read before the Japan Society in London. The history, present state and future prospects of the railways, with description of the important lines. 2600 w. Engr, Lond—March 3, 1899. No. 26529 A.

Light Railroad.

Note on the Operation of a Light Mineral Railroad. James Douglas. Statistics of the Arizona Southeastern Railroad. 1400 w. Trans Am Inst of Min Eng—Oct., 1898. No. 26253 D.

Russia.

Railway Traveling in Russia. From *Railroad Men*. An interesting account of conveniences furnished for night travel, and of manners and customs of the country. 2200 w. R R Car Jour—March, 1899. No. 26500.

FINANCIAL.**Australasia.**

The Cost of the Australasian Railways. Editorial remarks on the information furnished by Mr. Price Howell to the Royal Statistical Soc. 1400 w. Engng—Feb., 24, 1899. No. 26369 A.

Earnings.

Decreased Railroad Earnings in February. Gives a record of the month named, discussing causes, and giving comparison with preceding periods. 700 w. Bradstreet's—March 11, 1899. No. 26465.

India.

The East Coast State Railway. S. R. E. Observations on the present situation, analyzing the financial results so far obtained. 1000 w. Ind Engng—Jan. 28, 1899. No. 26339 D.

Operating Expenses.

A Method of Examining Operating Expenses. J. Shirley Easton. Suggestions for making expense returns, with explanations. 3400 w. R R Gaz—March 17, 1899. Serial. 1st part. No. 26559.

LEGAL.**Pooling.**

The Opposition to Railway Pooling. H. T. Newcomb. Discusses the question of competition among railways, and the facts and arguments which have favored the re-establishment of the pooling system, with the causes that have prevented effective legislation. 5500 w. N Am Rev—March, 1899. No. 26326 D.

Swiss Railways.

The Regulation and Nationalization of the Swiss Railways. Hans Dietler. Part first reviews the development of the rail ways, and the legislation affecting them up to 1872. 9400 w. An Am Acad—March, 1899. Serial. 1st part. No. 26536 F.

MOTIVE POWER AND EQUIPMENT.**Brakes.**

Air Supply and Demand in Freight Service. Substance of a paper presented at the Northwest Ry. Club. On the necessity of increasing the air-supply, and the economy of maintaining air pumps in first-class condition. 3300 w. Ry & Engng Rev—March 25, 1899. No. 26814.

Air Supply and Demand in Freight Service. From a report of the committee of the Northwest Ry. Club, showing that under severe conditions in freight train service the air supply is deficient, and recommending the use of large pumps and stopping the leaks. 1200 w. R R Gaz—March 10, 1899. No. 26455.

A Yard Installation for Testing Air Brakes. Illustrates and describes the plant at West Freight Yard, Wilmington, Del. 600 w. R R Gaz—March 24, 1899. No. 26654.

Inspection and Care of Air Brakes. Describes the practice of the Lake Shore & Michigan Southern Railway, at Buffalo. N. Y. 1500 w. Am Eng & R R Jour—March, 1899. No. 26300 C.

Brake Shoes.

Tests of the Corning Brake Shoe. Report of laboratory tests recently made by Prof. Goss, at Purdue Univ., to determine the frictional qualities. 700 w. R R Gaz—March 24, 1899. No. 26657.

Car Heating.

Note on the Status of Car Heating. (Note sur la Situation der Chauffage des Trains.) MM. Pfitzinger and Maucière. A very full review of the construction and operation of apparatus for heating railway carriages in Germany, Austria and Switzerland during the winter of 1897-98. Two articles. 12000 w. 9 plates. Rev Gen des Chemins de Fer—Feb., March, 1899. No. 26757 each F.

Car Lighting.

The Electric Lighting of the Prussian Railway Mail Cars. (Die Elektrische Beleuchtung der Preussischen Bahnpostwagen.) F. Milius. Storage batteries and incandescent lamps are used, about two-thirds of the mail cars in Prussia now being lighted by electricity. 1500 w. Elektro-Techniker—Feb. 15, 1899. No. 26783 B.

Corridor.

The Great Central New Corridor Trains. Illustrates and describes the rolling stock of the new line of the Great Central Ry. Co., England. 1600 w. Engr, Lond—March 10, 1899. No. 26600 A.

Couplers.

The Computation of the Strength of Bent Prismatic Bodies. (Zur Frage der Berechnung Gekrümmter Stabförmiger Körper.) A Bantlin. A discussion of the

strength of hooks used for coupling railway carriages; based upon Föppl's experiments at the Charlottenburg testing laboratory. 2000 w. *Zeit d Ver Deutscher Ing*—March 11, 1899. No. 26728 D.

The M. C. B. Coupler—Its History and its Performance in Service. William Garstang. An interesting review giving as a result of the researches, the opinion that the M. C. B. coupler, as adopted, is the best device for the purpose that has been presented to the railroad companies. 3000 w. *R R Gaz*—March 10, 1899. No. 26452.

Electric Locomotives.

Electric Driving on Main Line Railways. (Über Elektrischen Betrieb auf Vollbahnen.) C. P. Feldman. An important discussion of the requirements and possibilities of electric traction as applied to main line service. 7000 w. *Zeit d Ver Deutscher Ing*—Feb. 18, 1899. No. 26722 D.

Framing.

Car Framing. C. A. Seley. A discussion of the theories of F. M. Whyte, as set forth in a recent paper, with the writer's views. 1800 w. *Am Eng & R R Jour*—March, 1899. No. 26299 C.

Gondola Car.

80,000 lbs. Capacity Gondola Car for the Lake Terminal Railroad. Engravings, showing the principal features, with particulars. 600 w. *R R Gaz*—March 31, 1899. No. 26837.

Headlights.

Acetylene Gas for Locomotive Headlights. Illustrated description of an acetylene gas generator as applied to locomotives. The device was invented by A. M. Holland, of Ottawa, Canada. 1000 w. *Ry and Engng Rev*—March 4, 1899. No. 26414.

Locomotive Attachment.

Attachment for Locomotives, (Dispositif Applicable aux Locomotives.) A description of an electrical attachment for setting the brakes and reversing the engine automatically. 2500 w. *Revue Technique*—March 10, 1899. No. 26718 D.

Locomotives.

A Heavy Geared Locomotive. Illustrates a large geared engine recently built for the St. Paul & Tacoula Lumber Co., giving dimensions. 600 w. *Eng News*—March 9, 1899. No. 26448.

Ancient Locomotive Engines. Herbert T. Walker. Illustrates and describes three early English locomotives. 1500 w. *Sci Am*—March 18, 1899. No. 26547.

A New High Speed Locomotive. From *Le Génie Civil*. Illustrates and describes a proposed engine capable of maintaining a speed of 72 miles an hour. 800 w. *Sci Am Sup*—April 1, 1899. No. 26829.

British Locomotives in 1898. Illustrations with descriptions taken from an article by Mr. Charles Rous-Marten. 1800 w. *Transport*—March 3, 1899. No. 26508 A.

Consolidation Locomotive with Large Drivers for the Lehigh Valley Railroad. Illustrated description of an engine which is a departure from the usual practice. 350 w. *R R Gaz*—March 10, 1899. No. 26456.

Eight-Wheel, Class H, Passenger Locomotive—Wabash Railroad. Principal general dimensions with illustration. 500 w. *R R Gaz*—March 24, 1899. No. 26656.

Express Passenger Engine, Lancashire and Yorkshire Railway. Sections, with principal dimensions of the most powerful inside-cylinder passenger locomotive in England. 1500 w. *Engr, Lond*—March 17, 1899. No. 26807 A.

Schenectady Moguls for the Southern Pacific. Engraving and descriptive specifications. 350 w. *R R Gaz*—March 31, 1899. No. 26836.

Ten-Wheeled Passenger Locomotive. Buffalo, Rochester & Pittsburg Ry. Illustrations, particulars, and general dimensions. 500 w. *Eng News*—March 23, 1899. No. 26645.

The "Atlantic Type" Locomotive in Germany. General description, translated from an article by Mr. von Borries. Ill. 600 w. *R R Gaz*—March 17, 1899. No. 26562.

The New Compound Locomotives of the Central Railway of France. (Les Nouvelles Locomotives Compound de la Compagnie du Midi.) With outline diagrams of these new compound locomotives, and a comparison with the engines of the Northern Railway of France. 2000 w. *Revue Technique*—Feb. 25, 1899. No. 26714 D.

Types of Russian Locomotives. Nicholas Smirnoff. Illustrates and describes the locomotives of the St. Petersburg and Warsaw Railway. 400 w. *Loc Engng*—March, 1899. No. 26347 C.

Resistance.

A New Formula for Train Resistance. Editorial discussion of a new formula by John Lundie, given in the *Street Railway Journal*. 1100 w. *Engr, Lond*—Feb. 17, 1899. No. 26217 A.

A New Train Resistance Formula. Comment on the Lundie formula published in the *Street Railway Journal*. 1700 w. *Loc Engng*—March, 1899. No. 26348 C.

A New Train Resistance Formula. Mr. Lundie's formula, as given in the *Street Railway Journal*, with editorial comment. 2200 w. *Ry Mas Mech*—March, 1899. No. 26407.

The Baldwin Train Resistance Formula. An account of the Baldwin trials and deductions on which the formula was based.

800 w. R R Gaz—March 17, 1899. No. 26558.

The Resistance of Loaded and Empty Freight Cars. Gives results of some interesting dynamometer tests made a few years ago, which show the relation between loaded, partially loaded and empty freight cars. Also editorial. 1800 w. R R Gaz—March 24, 1899. No. 26658.

Train Resistance. John Balch Blood. Criticises methods used by Mr. Lundie, and gives calculations made by the writer and other tests. Also a number of letters to the editor in regard to the Lundie formula. 4500 w. St Ry Jour—March, 1899. No. 26416 D.

Sleeping Cars.

Sleeping Cars for the Florida East Coast Railway. Illustrated description of luxurious cars recently built. 900 w. R R Car Jour—March, 1899. No. 26499.

Special Car.

A Car with Depressed Platform. (Note sur un Wagon à Plateforme Surbaissée.) M. J. Koechlin. A description, with detail drawings, of a special car with the bottom depressed as low as possible, to permit large pieces of machinery to be shipped. 250 w. 2 plates. Rev. Gen des Chemins de Fer—March, 1899. No. 26,758 F.

NEW PROJECTS.

Africa.

From Djibouti to Harrar. From *Le Monde Illustré*. Illustrations with particulars concerning this section of the road. 1700 w. Sci Am Sup—March 4, 1899. No. 26292.

Australia.

Railways in Western Australia. Notes the difficulties met and the wisdom of the policy adopted, giving information concerning these railways. 1200 w. Engng—Feb. 17, 1899. No. 26223 A.

Canadian Railroads.

Canadian Railroad Building, Recent and Prospective. Detailed account of work in Manitoba, British Columbia, and extensions and improvements in general. 1800 w. R R Gaz—March 31, 1899. No. 26840.

Extensions.

Railways in Burma and Their Proposed Extension Across Yunnan. John Nisbet. Discusses the proposal to extend the railway now being constructed to the eastward, concluding that the present prospect of trade does not warrant the expense. Also general discussion. Map. 13000 w. Jour Soc of Arts—Jan. 27, 1899. No. 26489 A.

Intercontinental.

The Inter-Continental Railroad. Editorial on the work of the Commission and their recently issued report. 1500 w. R R Gaz—March 3, 1899. No. 26323.

The Railway Systems of Central and South America. An abstract of the report of the Inter-continental Ry. Commission, showing the principal technical features and giving an account of the surveys. Ill. 6000 w. Eng News—March 23, 1899. No. 26642.

Soudan Railways.

The Railways of the French Soudan. From *Le Monde Illustré*. Gives a list of projected and completed railways, and some particulars and illustrations. 600 w. Sci Am Sup—Feb. 4, 1899. No. 25698.

Transcaspian.

The Transcaspian Railway. Alexis Krausse, in *Black and White*. Describes and illustrates this railway, constructed by Russian engineers over a country which is mostly a sandy desert. It has engineering features of special interest. 1800 w. Sci Am Sup—March 11, 1899. No. 26434.

Tunis.

The Construction of the Railway from Sfax to Gafsa. (Construction du Chemin de Fer de Sfax a Gafsa.) L. Rey. An account of the construction of a railway in Tunis for the exploitation of the phosphate deposits. Steel sleepers are used, the track being laid in sections. 2500 w. Soc Ing Civ de France—Dec., 1898. No. 26025 F.

PERMANENT WAY AND FIXTURES.

Boston Terminal.

The New South Terminal Station in Boston and its Effect on Traffic Conditions in Eastern Massachusetts. An interesting article giving a brief description of this new station with its peculiarities, and discussing its influences on transportation conditions. Ill. 2800 w. St Ry Jour—March, 1899. No. 26418 D.

Early Railroadng.

Some Railroaders of 1850. Walter S. Phelps. A brief account of early railroadng and of the first frog devised for the Milwaukee & Mississippi. 800 w. R R Gaz—March 24, 1899. No. 26653.

Frogs.

Formulas for Locating Frogs. Malverd A. Howe. Gives a method for locating a given frog requiring only a few simple formulas for all the cases that ordinarily occur. 400 w. R R Gaz—March 10, 1899. No. 26454.

Masonry.

Expansion Joints for Retaining Walls on the St. Charles Air Line Ry., Chicago. Describes a novel feature introduced in the construction, which is of interest to engineers. 450 w. Eng News—March 9, 1899. No. 26445.

Paris.

The Railway from Courcelles to Passy. (Le Chemin de Fer de Courcelles à

Passy.) A description of the extension of this local railway to the Champ de Mars, with details of work on tunnel and bridges. 2500 w. *Revue Technique*—March 10, 1899. No. 26717 D.

Permanent Track.

Permanent Way for Steam Railways. Letters criticising features of designs suggested in recent paper of J. W. Schaub, and presenting other plans for improvement. Ill. 4000 w. *Eng News*—March 23, 1899. No. 26644.

Rail Joints.

Bridge Rail-Joints. (Stossfugenüberbrückung.) Dr. Zimmerman. A discussion before the German Railway Society, of the recent paper by Dr. Vietor, with especial reference to the influence of impact upon the rails and joints. 5000 w. *Glaser's Annalen*—March 1, 1899. No. 26734 D.

Rail-Sections.

Important Results Obtained in the Past Fifteen Years with the Stiff and Heavy Rail-Sections. P. H. Dudley. Reviews the results secured on various roads, and the progress made in railway engineering. 4500 w. *Trans Am Inst of Min Engs*—Feb., 1899. No. 26484 D.

Rail Trimming.

Rail Trimming on the Michigan Central and Santa Fe Roads. An illustrated detailed description of one of the plants engaged in the work of rail-trimming. 2500 w. *Ry and Engng Rev*—March 4, 1899. No. 26412.

Shed.

The Temporary Shed over the New Lyons Railway Station. (La Charpente-Abri de la Nouvelle Gare de Lyon.) An illustrated account of the temporary structure erected to protect the works of a new railway station in Paris, also describing the traveling cranes and erecting plant. 2000 w. *Génie Civil*—March 4, 1899. No. 26705 D.

Signals.

Automatic Block Signals on the Southern Pacific at Los Angeles. Brief description of automatic semaphore block signals worked by electric motors. 350 w. *R R Gaz*—March 17, 1899. No. 26563.

Electric Block Signals in Austro-Hungary. (Die Elektrischen Blocksignale in Oesterreich-Ungarn.) L. Kohlfürst. A detailed description of the systems used on the Austrian State railways, with diagrams. 2000 w. *Elektro-Techniker*—Feb. 28, 1899. No. 26784 B.

Inspection of Automatic Block Signals. Comments by G. W. Blodgett, with editorial. 2800 w. *R R Gaz*—March 17, 1899. No. 26560.

The Arrangement of Electric Railway-Signals. (Dispositif Electrique Applicable aux Signaux de Chemins de Fer.) A de-

scription of an improved system of electrical control adapted to be used with the signal systems at present in use on the French railways. 2500 w. *La Revue Technique*—Feb. 25, 1899. No. 26712 D.

The Closing of Block Signals by Electric Switch Connections. (Ueber den Anschlurs von Stellwerksanlagen mit Elektrischem Weichenstrassen-Verschlusse an Blocklinien.) Martin Boda. An elaborate analysis of electric block signals as applied to the railways of Austro-Hungary. 6000 w. *Zeit d Oesterr Ing u Arch Ver*—Feb. 17, 1899. No. 26730 B.

Sleepers.

The Computation of Cross-Tie Structures. (Beitrag zur Berechnung des Querschwellen oberbanes.) Prof. Skibinski. A very complete mathematical discussion of the stresses in railway sleepers, with numerous diagrams and tables, both for metal and wooden sleepers. Two articles. 9000 w. *Zeit d Oesterr Ing u Arch Ver*—Feb. 24, March 3, 1899. No. 26732, each B.

Terminal.

The New Terminal of the Orleans Railway at the Quai d'Orsay. Jacques Boyer. A handsomely illustrated account of the important terminal works now in construction, which will bring the Orleans railway into the heart of Paris. 5000 w. *Engineering Magazine*—April, 1899. No. 26819 B.

The Prolongation of the Orleans Railway. (Prolongement de la Ligne d'Orléans.) Describing especially the use of the shield in connection with the tunneling under the quai de la Tournelle. 3500 w. 1 plate. *Génie Civil*—Feb. 11, 1899. No. 26700 D.

Trans-Siberian.

The Trans-Siberian Railway. (La Ferrovia Transiberiana.) E. Pattacini. A general review of the routes of the various sections of the road, with data as to time and cost of construction and statements of the present condition of the work. Serial. Part 1. 2000 w. *Gior d Lav Pubb e d Str Ferrate*—Feb. 8, 1899. No. 26789 D.

TRAFFIC.

Car Hire.

The Settlement of Car Hire Accounts on Per Diem or Mileage Basis. J. M. Daly. A discussion of the irregularities of the mileage plan, and favoring the per diem basis. Discussion by members. 15000 w. *N Y R R Club*—Feb. 16, 1899. No. 26618.

Freight.

Freight Transferring. C. W. Nash. Notes the steps recently taken to improve the handling of freight, describing the method as conducted at the railroad department of the D & H. C. C., at Mechanicsville, N. Y. 1100 w. *Ry and En-*

gng Rev—Feb. 25, 1899. Serial. 1st part. No. 26278.

Freight Loading System at Richmond, Va. Edwin H. Lea. Describes in detail a system that has been working satisfactorily for ten years. 2300 w. R R Gaz—March 24, 1899. No. 26659.

Italy.

Notes on the Railways in the Valley of the Tiber. (Considerazioni Sulla Ferrovia in Valle Tiberina.) A review of the railways of central Italy, and the connections necessary to unite them more effectively with the main lines of Italy and Central Europe. 3000 w. Gior d Lav Pubbe d Str Ferrate—Feb. 22, 1899. No. 26790 D.

St. Gothard.

The Operation of the St. Gothard Railway in 1897. (Résultats de l'Exploitation de Chemin de Fer du Saint Gothard pendant

l'Année 1897.) Jules Michel. A general examination of the traffic between Italy and Switzerland, with diagrams showing the growth of various branches of the service since 1883. 3500 w. Rev Gen des Chemins de Fer—Feb. 1899. No. 26755 F.

Ticket Scalping.

The Ethics of Ticket Scalping, A discussion of scalping from the economic and the moral points of view. 3700 w. Gunton's Mag—March, 1899. No. 26359 C.

Transport Charges.

The Commercial Meaning of Transport Charges. (Ueber die Wirthschaftliche Bedeutung der Gütertarife.) Bergrath Gothein. An address delivered before the Silesian ironmasters, discussing especially the relations of railway charges to the coal mining industry. 4500 w. Stahl und Eisen—Jan. 1, 1899. No. 26039 D.

STREET AND ELECTRIC TRAMWAYS

Air Brakes.

The Standard Air Brake for Street Cars. Illustrates and describes the brakes that are to be applied to the 160 cars now being built for the electric service of the Third Avenue Railroad in New York City. 1700 w. R R Gaz—March 31, 1899. No. 26838.

Blackburn.

Electric Tramways at Blackburn. Illustrated detailed description of an English plant. 2500 w. Elec Eng, Lond—March 17, 1899. No. 26800 A.

Cable.

The Electric Cable-Road at Mont-Dore. (Die Elektrisch Betriebene Seilbergbahn in Mont-Dore.) A three-phase current operates a motor which hauls the cars to the top of the incline by a cable. The power is derived from a hydraulic station in the valley $1\frac{1}{4}$ miles distant. 2000 w. Elektrotech Zeitschr—Feb. 23, 1899. No. 26764 B.

Construction.

Some Details of Street Railway Construction. W. H. Rosencrans. Describes the lines in and about South Bend, Ind. Ill. 1700 w. Munic Engng—March, 1899. No. 26328 C.

Development.

Electric Tramway Development. Editorial discussion of the development in England and the points needing special attention. 1800 w. Engr, Lond—March 3, 1899. No. 26527 A.

Double-Track.

Double-Track Electric Railway from Butte to Centerville, Montana. Francis W. Blackford. Particulars concerning the change made from cable to electric trac-

tion. Ill. 700 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26333 C.

Electric Locomotives.

See Railway Affairs, Motive Power.

Electrolysis.

See Municipal Engineering, Water Supply.

Equipment.

Power and Equipment of Electric Railways. H. H. Hunt and C. K. Stearns. Reviews the events that mark the progress of the application of electricity to street car propulsion, and outlines the problems in design, and the method of treatment. 5600 w. Jour Assn of Engng Soc's—Jan., 1899. No. 26332 C.

Interurban.

The Dayton and Western Interurban. Illustrates and describes an interurban road extending 25 miles west of Dayton, O., as an example of latest practice. 1200 w. St Ry Rev—March 15, 1899. No. 26627 C.

Lawsuit.

Legal Victory for the Aurora & Geneva Railway. Discusses the decision of the Illinois Supreme Court in regard to the right of an interurban electric railway to leave the highway and condemn a right of way through private property. Gives a detailed statement of the facts and circumstances. 7200 w. St Ry Rev—March 15, 1899. No. 26626 C.

Loop.

The Chicago Elevated Loop. Henry M. Sperry. Brief illustrated description of the loop and stations is given in part first. 1100 w. R R Gaz—March 17, 1899. Serial. 1st part. No. 26561.

Monaco.

The Electric Tramway at Monaco. (Die Elektrische Strassenbahn in Monaco.) An interesting installation of the point-contact system, with illustrations of the work in construction and after completion. 1500 w. Ill. Zeitschr f Klein u Strassenbahnen—Feb. 1, 1899. No. 26787 D.

Mountain Roads.

Mountain Electric Railways. W. L. Hedenberg. Reviews some of the early attempts to climb mountains by mechanical means, describing and illustrating some of the electrically operated roads. 2500 w. Elec, N. Y.—March 22, 1899. No. 26637.

Pittsburg.

New Power Station, Repair Shops and Car Houses of the Consolidated Traction Company of Pittsburg. An illustrated study of the reconstructed system of this company, which presents many interesting features. 8400 w. St Ry Jour—March, 1899. No. 26415 D.

Power Station.

Power Station of the Market Street, Railway Company, San Francisco, Cal. Illustrates and describes the station supplying current for the operation of the electric system. 700 w. Power—March, 1899. No. 26297.

Rail.

New Girder Rail of the General Omnibus Company of Paris. (Nouveau Rail-Poutre de la Compagnie Générale des Omnibus de Paris.) M. Delonchant. With sections of rails and joints, and drawings of fish plates. 1000 w. Rev. Gen des Chemins de Fer—Feb., 1899. No. 26,756 F.

Rail-Bonding.

The Electrical Connection of Tramway Rails. (Connexion Electrique des Rails de Tramways.) Ch. Thonet. A report presented at the Geneva meeting of the International Union of Tramways, reviewing the principal methods of rail-bonding employed in Europe and America. Two articles. 3000 w. L'Electricien—March 11, 18, 1899. No. 26777, each B.

Rapid Transit.

Rapid Transit in New York City. Editorial on the proposition of the Metropolitan Street Railway Company to build and operate the tunnel railroad which the Commissioners have long been trying to get built. 1200 w. R R Gaz—March 31, 1899. No. 26839.

Return Feeders.

Return Feeders for Electric Railways. Translation of article by Br. Böhm-Rofay, in *Elektrotechnischer Neuigkeits-Anzeiger*, giving simple formulæ, or graphical methods of determining the sec-

tion and volume of the return feeders. 1800 w. Elec Rev, Lond—March 3, 1899. Serial. 1st part. No. 26514 A.

Stray Currents.

See Electrical Engineering, Measurement.

Traction.

Commercial Aspects of Electrical Traction in Great Britain. Emile Garcke. A discussion of present conditions, showing how onerous conditions and municipalizing tendencies have hampered the progress which might otherwise have been made. 5000 w. Engineering Magazine—April, 1899. No. 26818 B.

Electric Traction by Surface Contacts. Miles Walker. Read before the Brit. Inst. of Elec. Eng. Discusses whether a surface-contact system can be laid so as to cause no obstruction to traffic; whether picking up current from studs by means of a skate is feasible under practical working conditions, and whether the studs can be made perfectly safe. Ill. 3800 w. Ind and Ir—Feb. 17, 1899. Serial. 1st part. No. 26228 A.

Traction by Electrical Power. A. C. Elliott. Read before the Inst. of Marine Eng. Brief review of the various systems. 2500 w. Prac Engr—Feb. 17, 1899. No. 26229 A.

Traveling Platform.

Electric Transportation at the Exposition of 1900. (Les Transports Electriques de l'Exposition de 1900.) An account of the tests made upon the trial platform submitted by M. de Mocomble for the Exposition; with numerous illustrations. 1800 w. 1 plate. Génie Civil—Feb. 18, 1899. No. 26702 D.

Underground.

Building an Underground Railway. Abstract of a lecture by Basil Mott, giving a description of the construction of the Central London Railway. 1800 w. Builder—Feb. 18, 1899. No. 26205 A.

The Future of the "Underground" Railway. George Frederick Bird. Discusses the series of experiments being undertaken with the object of adopting electric traction and outlines a scheme for rendering more efficient service and overcoming the objectional features. 4500 w. Engr, Lond—Feb. 3, 1899. No. 25919 A.

The Passy Underground Railroad. From *La Nature*. Interesting particulars of the construction work. Ill. 1800 w. Sci Am Sup—March 25, 1899. No. 26639.

The Underground Railway of Boston. Jane A. Stewart. An illustrated account of this successful undertaking, and the relief it has proved to the congested traffic of the city. 3000 w. Chau—March, 1899. No. 26281 C.

BOOK REVIEWS

THE AUTOMOTOR AND HORSELESS VEHICLE POCKET BOOK. London: P. King & Co., Ltd., 1899.

In the first place, we notice that the present edition of 271 pages has increased from 212 pages in 1898, and that the amount of advertising has nearly doubled. All of the useful matter which was in the previous edition has been retained in the present one and much of importance has been added. The compiler says in his preface "That the former issues of this work have met a distinct want on the part of those engaged in the Moto-Vehicle industry is shown by the fact that every copy of them has been sold." We are not surprised to learn this for there was and is need of such a pocket book, and this is one which compares favorably with any of any of its fellows in any class.

THE TRACTION ENGINE. Its Use and Abuse. By James H. Maggard. Philadelphia: David McKay, Publisher.

This little book is a well written one and treats of a subject which is of constantly increasing importance. The dangerous expedient is adopted of a supposedly intimate conversation between the writer and the reader, but the plan has been carried out with entire success and without ever falling into the vulgarities and commonplaces which are so frequent in works of the kind. Every word tells, and the peculiarities of form are soon lost sight of in the clearness of the language and the continuity of the narrative. If there is a fault, it is in the quality of and the limited number of the engravings. We heartily recommend the book to anyone, whether experienced or not, having much to do with traction engines.

THE COFFER DAM PROCESS FOR PIERS. By Charles Evan Fowler, Mem. Am. Soc. Civ. Engrs. New York: John Wiley & Sons, 1899.

This is one of the books which, once taken up, it is hard to lay down before it is finished without at least forming a resolution to return to it soon. Not that it presents anything particularly new, strange or

startling, but because what it does give, is so unusually well given. There is here collected a mass of information which is of the highest value to a civil engineer, particularly a young one, and which it is doubtful if he could secure in any other way except by doing the very work that the author has been forced to perform in preparing the book for the press.

A short but interesting chapter on the history of foundations opens the work. This is followed, in the order given, by Construction and Practice, Pile Driving and Sheet Piles, Construction with Sheet Piles, Metal Construction, Pumping and Dredging, The Foundation, Location and Design of Piers. An Appendix devoted to specifications for different kinds of work, together with a very good index, concludes the book. The illustrations, 104 in number, are of a high order and accomplish the purpose for which they were intended.

HANDBOOK OF METALLURGY. By Dr. Carl Schnabel. Translated by Henry Louis, M. A. Two Volumes. London: Macmillan & Co., Limited, New York: The Macmillan Co., 1898.

The appearance of an English translation of Dr. Schnabel's treatise on metallurgy goes a long way towards filling an important gap in technical literature. Many years ago the late Dr. Percy commenced the publication of his monumental work on metallurgy, with the intention of devoting an entire volume to each metal, these being preceded by a volume on Fuel, but this great work remains a fragment, and new processes and methods have in the meantime come into use.

Dr. Schnabel's work, of which the first volume originally appeared in 1894, and the second two years later, makes no pretensions to the elaborate completeness of Dr. Percy's treatises, but bears the more modest name of "handbook," although the condensed style and compact make-up of the handsome volumes permits a very full treatment of the modern methods which are employed in actual practice. With this

is given a concise statement of the scientific principles underlying the methods employed, the whole forming a general treatise on metallurgy amply sufficient for the needs of the student.

Although the work is entitled a handbook of metallurgy, its contents are really limited to the narrower field implied by this title in Germany, there being nothing in the treatise about the metals of the iron group. This is doubtless a wise provision, both because of the magnitude of this omitted branch, and because of the existence of other treatises which fill the gap.

The entire first volume is devoted to the four metals, copper, lead, silver and gold, and forms the most important portion of the work. Here are gathered, in a necessarily condensed form, illustrated descriptions of the methods and processes in use for the extraction of the metals named, including the later methods of gold extraction, as applied in South Africa and elsewhere, Mr. Louis here having supplemented Dr. Schnabel by the later information gathered since the publication of the German original, including data concerning electrolytic methods.

In the second volume are given the methods of smelting zinc, cadmium, mercury, bismuth, tin, antimony, arsenic, nickel, cobalt, platinum and aluminum, more than one-third of the volume being devoted to zinc. A very full discussion

of the electrolytic method of extracting zinc is given, including both the direct extraction from the ore, and also the electrolytic separation from alloys, this forming one of the most valuable portions of the whole treatise. Mercury is also given a very full treatment, the methods employed at Idria, Almaden and New Almaden being illustrated and described at length. Aluminum is hardly given so full a treatment as its growing importance would seem to warrant, but this may be due to the fact that separate treatises are available entirely devoted to the subject. Nickel and tin are given excellent discussions, and in general, the work in both volumes is of the high character which might be expected from the names of the author and translator.

In one respect especially, the work demands high praise, i. e., in the completeness of the index. Not only is there a very full general index, but this is preceded by a geographical index of equal completeness, so that not only may any subject be readily found in the usual manner, but all the references to any locality are grouped in the geographical index under the name of the place, a most admirable idea, and worthy of imitation in other works of this kind.

The typography and illustrations of the volumes are most excellent, and the work will doubtless become a standard textbook in many places.

NEW CATALOGUES AND TRADE PUBLICATIONS

These catalogues may be had free of charge on application to the firms issuing them.

Please mention The Engineering Magazine when you write.

Measures Brothers, Ltd., Southwark St., London.—Pocket section book of joists, cast iron columns and builders' ironwork.

Mitchell's Emery Wheel Company, Mill St., Bradford, Manchester, England.—Illustrated price list of grinding machinery and emery wheels.

Lake & Elliot, Albion Works, Braintree, England.—Illustrated price list of tools for cycle makers and repairers.

E. F. Blakeley & Co., Vauxhall Road, Liverpool, England.—Circular with illustrations of iron and steel buildings erected by the firm.

Thos. Henderson, 6 and 8 Trueman St., Liverpool, England.—Circulars describing patent self-cleaning boiler furnaces.

Lucas & Gliem Machine Works, Philadelphia, Pa., U. S. A.—Handsome catalogue of fine machine tools, with reproductions of blue-print illustrations of cutting-off machines, milling machines, boring machines and other standard and special tools.

The Bucyrus Company, South Milwaukee, Wis., U. S. A.—General catalogue of dredging and excavating machinery for every purpose, with numerous illustrations and detailed specifications of the powerful and efficient machines built by this company. An excellent presentation of American practice in this important field.

The Trenton Iron Company, Trenton, N. J., U. S. A.—Special catalogue of cable hoist conveyors, fully illustrating the functions and operation of this apparatus as distinguished from wire rope tramways. Illustrations of many installations are given.

A. C. Wells & Co., 102 Midland Road, St. Pancras, London.—Series of illustrated price lists of (a) The "Wells" light for lighting up works at night; (b) Wells' oil lamps for workshops, offices, etc.; (c) small cast metal lamps, plumbers' furnaces, etc.; (d) waste oil filters and tinned steel oil cisterns; (e) Wells' lightning painter, being a pneumatic painting machine.

J. Rhodes & Sons, Wakefield, Yorkshire, England.—(a) Illustrated and descriptive catalogue of presses, dies and special machines for working sheet metals and wire, with full index; (b) price list of machines described in above catalogue.

Wright's Patent Heater Condenser Company, Great George St. Chambers, London, S. W.—Pamphlet by Mr. Howard Wright describing the softening and purification of water according to the firm's system. Illustrated.

Bullivant & Co., Ltd., 72 Mark Lane, London, E. C.—Catalogue of wire ropes, wire netting, aerial tramways and mining and hauling plant. Illustrated, and with copious extracts from the technical press.

Sprague Electric Company, New York.—Advance sheets of catalogue of electric fans for household and general purposes, including proofs of handsome illustrations, showing the applications of the Lundell fan-motor. These sheets are gems

of the designer's and engraver's art, and indicate the very attractive character of the forthcoming catalogue.

Kelley Island Lime and Transport Company, Cleveland, Ohio, U. S. A.—Catalogue of the Lägerdorfer high grade Portland cement, giving data of tests and many illustrations of important constructions in the United States in which this cement has been used.

The Ingersoll-Sergeant Drill Company, New York.—Catalogue No. 41, containing descriptions, illustrations and specifications of mining, tunnelling and quarrying machinery, including much useful information upon these subjects of value to the engineer and contractor.

Clayton & Shuttlesworth, Lincoln, England.—Price list of patent oil engines, either fixed or portable. Fully coded.

W. F. Stanley, Great Turnstile, Holborn, London.—Illustrated price list of drawing and surveying instruments.

Tolch & Co., Fulham, London, S. W.—Illustrated and descriptive price list of oil engines and oil launches, with testimonials from users.

Jno. Staniar & Co., Manchester Wire Works, Manchester, England.—Album of designs for woven wire, perforated plates and jiggers.

Joseph Wright & Co., Tipton, Staffs., England.—Price list and catalogue of feed water heaters, surface and evaporative condensers, grease filters, water softeners, etc. Also of wagon and tram couplings, chains, anchors and other forgings.

Sir Theodore Fry & Co., Rose Carr Rolling Mills, Darlington, England.—Section book in cloth cover of iron and steel bars and rails and special sections for wagon makers and other trades.

Rice & Co., Elland Road, Leeds, England.—Catalogue of hydraulic tools, such as cranes, presses, riveters; also of pumps, hydraulic valves, etc. Handsomely illustrated and fully coded, with brief description of machines.

Austin Separator Company, Detroit, Mich., U. S. A.—Illustrated catalogue of the Austin steam and oil separators, with numerous testimonials from users in all parts of the United States.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.—Record of recent construction, No. 11, containing a paper upon the performance of a four-cylinder compound locomotive, presented before the St. Louis Railway Club, together with the very full discussion by the members of the club. An interesting presentation of this important subject from a practical point of view.

Rand Drill Company, New York.—Handsomely illustrated catalogue (D) of rock drills and drill mountings for mines, quarries and tunnels, with interesting historical matter, referring to important works upon which the Rand drills have been used.

B. F. Sturtevant Company, Boston, Mass., U. S. A.—Catalogue No. 96, devoted to the special subject of steel-plate fans, showing designs for a

vide variety of applications and specifications of dimensions and capacities. A number of tables for consultation in connection with the movement of air are appended.

Gandy Belt Manufacturing Company, Ltd., Seacombe, Cheshire, England.—Illustrated price lists of (a) belting and hose of several varieties; (b) the Dodge wood split pulley.

Drum Engineering Company, 27 Charles St., Bradford, England.—Illustrated price list of the "Drum" pumps, blowers and exhausters.

The Conduit and Insulation Company, Ltd., 63 Queen Victoria St., London, E. C.—(a) Price list of steel armored insulating conduit and accessories; (b) two pamphlets written by Mr. F. Bathurst dealing with "Electric Wiring Practice" and the "Prevention of Fire Due to Leakage of Electricity."

The New Incandescent Gas Lighting Co., Ltd., 33 Shoe Lane, London.—Large illustrated price list of incandescent burners, lamps, globes, pendants and other lighting requisites.

Isaac Hill & Son, St. George's Engineering Works, Derby, England.—Illustrated catalogue of cold sawing machinery; also of machines for sawing hot iron castings, etc., with long list of testimonials.

Loring Coes & Co., Worcester, Mass., U. S. A.—Catalogue of machine knives for wood-working machinery, leather-splitting machines, paper cutters, agricultural machinery, &c., describing the application of concave grinding and of "pyrocalcic" tempering, and showing the high degree of precision which has been attained in this class of work.

Almy Water-Tube Boiler Company, Providence, R. I., U. S. A.—General catalogue of the Almy sectional water-tube boiler, with especial reference to its application to marine service, as well as to stationary practice.

The Risdon Iron Works, San Francisco, Cal. U. S. A.—(a) Catalogue No. 12, of milling machinery for use in the treatment of gold, silver, copper, lead and other ores; (b) Catalogue No. 5, describing the Evans hydraulic elevator and other hydraulic mining machinery; (c) Catalogue No. 17, devoted to gold dredging machinery, with numerous examples of the system of dredging river beds for gold.

McLachlan & Co., Haughton Bridge Works, Darlington, England.—Illustrated catalogue of railway wagons and mining tubs, built in either wood or steel, and for side, end or all round tipping.

Gresham & Craven, Ltd., Ordsall Lane, Manchester, England.—Catalogue of injectors and other specialties for railway work, handsomely illustrated in half-tone. Devices for sanding and carriage warming and hose couplings are also described.

Société Anonyme des Forges, Usines et Fonderies de Gilly, Gilly, Belgium.—(a) Illustrated catalogue of steam hammers and briquette making machinery; (b) series of sheets with sectional views of locomotives with particulars.

Thwaites Brothers, Vulcan Iron Works, Bradford, England.—Pamphlet describing Stewart's patent cupola, and other foundry plant.

Geo. Richards & Co., Ltd., Broadheath, Man-

chester, England.—Illustrated catalogue of wood-working machinery.

American Hard Rubber Company, New York.—Catalogue of hard-rubber pumps, pipes and fittings, adapted for the pumping and conveyance of acids, salt water or other liquids with which contact with metal is objectionable.

Westinghouse, Church, Kerr & Co., New York.—"A Few Words About Mechanical Stokers," being a very handsome pamphlet descriptive of the construction and performance of the new Roney mechanical stoker as applied to steam boilers; showing the advantages of mechanical stoking in regard to economy, smokelessness, adaptability of low-grade fuels, and general efficiency of steam plants. Illustrations of numerous large installations are given.

The Wilkinson Manufacturing Company, Philadelphia, Pa., U. S. A.—Catalogue of the Wilkinson automatic stoker, showing the construction and operation of the device, together with numerous testimonials and illustrations of many large buildings and manufacturing establishments using the stoker.

The Watson-Stillman Company, New York.—Illustrated index of hydraulic tools and miscellaneous machinery, forming Catalogue No. 51, and consisting entirely of miniature illustrations of the various machines, with their names and reference numbers to detailed sheets.

A. Ransome & Co., Ltd., Stanley Works, Chelsea, London.—(a) Large illustrated catalogue of wood working machinery in great variety with full descriptions and code words. Among the new machines may be mentioned some log band sawing machines, a rack circular saw bench with supplementary top saw and a crosscut saw for hard wood paving blocks; (b) price list of machines described in above catalogue.

Cowans, Sheldon & Co., Ltd., St. Nicholas Works, Carlisle, England.—Illustrated cloth-bound catalogue and price list of lifting machinery and railway plant, principally describing cranes, turntables, water columns, etc. Very fully coded.

The Brush Electrical Engineering Company, Ltd., 49 Queen Victoria St., London, E. C.—Cloth bound pamphlet describing the methods of working and the component parts of the "Universal" vertical engine.

J. E. H. Andrews & Co., Ltd., Reddish, nr. Stockport, England.—(a) Descriptive catalogue of the "Stockport" gas engine with illustrations and particulars of different sizes; also statement of advantages claimed; (b) latest price list of the Stockport gas engines.

Merryweather & Sons, Ltd., 63 Long Acre, London, W. C.—Illustrated catalogue and price list of the portable "Valiant" steam pumping engine, with description of its application to irrigation, mining, water supply, fire extinction and other purposes. Fully coded.

John Gordon & Co., 9 New Broad St., London, E. C.—Illustrated catalogue of colonial machinery for coffee, sugar, rice and other produce. Prices and particulars are given.

The Magnolia Anti-friction Metal Company, Ltd., 49 Queen Victoria St., London, E. C.—Perpetual calendar in red and gold for hanging on wall.

THE ENGINEERING MAGAZINE

VOL. XVII.

JUNE, 1899.

No. 3.

THE WORK OF THE NAVAL REPAIR SHIP VULCAN.

By Gardiner C. Sims and Wm. S. Aldrich.

THE abandonment of sails and the universal introduction of steam engines for the propulsion of naval vessels have wrought great changes in naval economics. Vast steam motive powers and a multitude of auxiliary machines are all to be kept in a state of readiness for service and of efficiency of operation. The maintenance and repair of such varied mechanisms of a modern war vessel are ever pressing questions with the commanding officer, even in the piping times of peace. In the storm and stress of war, however, the whole life of the naval service is more complex, its requirements more exacting. Readiness for action and efficiency of service become most imperative demands.

Vessels cannot resort to naval stations whenever supplies and repairs are needed in war time. Some provision must be made to supply the lack of navy-yard facilities. "No one can understand the value of such an adjunct who has not had to look around for ships to go on duty, the long list of waiters for repairs or overhauling was sometimes heartbreaking; a full third of such a fleet as ours had at all times been counted off as unavailable for such reasons and others." Thus writes Capt. F. E. Chadwick, U. S. N., the Commanding Officer of Admiral Sampson's flagship.

The performance of the battle-ship Oregon, in view of these facts, becomes still more remarkable. Such a record would seem to controvert the necessity for naval repair ships. Fourteen thousand five hundred miles from the Pacific to the Atlantic, on blockade duty off Santiago, actively engaging Cervera's fleet and chasing the Colon,

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all without any repairs to the motive-power machinery other than those usually executed on board the Oregon,—will go down into history as a feat unparalleled in the annals of naval engineering.

The engineer in all branches of his profession is a true economist. Anticipating the unexpected he diligently prepares such measures as shall prevent the unexpected from happening. Before the late war, the Engineer-in-Chief of the Navy, Rear Admiral George W. Melville, U. S. N., brought to the attention of the Secretary of the Navy, "the desirability of making such preparation for the fitting out of a vessel which would be a floating repair shop as would enable the work to be done with great rapidity when needed."

Scarcely had war been declared when active preparations were made to carry out this recommendation. The steamship Chatham, of the Merchants & Miners Transportation Co., was purchased by the Government, sent to the Boston Navy Yard, overhauled, fitted out, renamed Vulcan, placed in commission May 22, sailed for Cuba, June 22, reported to Admiral Sampson, off Santiago, on the morning of July 1, and was ordered to the naval base, Guantánamo Bay, thirty-six miles to the eastward. Here the Vulcan came to anchor, in the afternoon of the same day, and entered at once upon her long career, as a repair ship for the fleet.

Fitted out with the most approved workshop appliances, with a large and varied assortment of engineers' and ship's stores, and a picked complement of skilled mechanics, the Vulcan was pre-eminently an "engineer's ship." The project was in no sense an experiment. Had it been looked upon as such, it passed beyond the experimental stage in less than twenty-four hours after reporting for duty to Admiral Sampson.

The first requisition for repairs came abroad while off Santiago. It was from the torpedo-boat Ericsson, for a pair of new brass tappets for valve stem of steam pump. As soon as the Vulcan came to anchor in Guantánamo Bay she was pressed into service for an unusually large amount of all conceivable kinds of repair work. Many of the ships evidently had been expecting her arrival much earlier. The work awaiting repairs had so far accumulated that the Vulcan's force, in three shifts, was kept steadily at it, night and day. Two days later came the news of Cervera's *sortie* and the utter destruction of his fleet. It seemed to spur the men on to still greater exertion, culminating in the preparation of the Eastern and Covering Squadrons for the coast of Spain. These chosen vessels of Admiral Sampson's fleet were overhauled and fitted out by the

Vulcan, single-handed and alone, more than two thousand miles from a navy yard, and reported ready to set sail for Spain. The result was the signing of the protocol, August 12th.

The Chatham, now the Vulcan, was the sister ship of the Berkshire, built by the American Ship Building Co., of Philadelphia, in 1884. She was well designed, strongly built, and for years had been a credit to the early work of this company. The original interior arrangements seemed to be particularly adapted to meet the requirements of her new line of service in the auxiliary navy. On each deck were ample gangways, on each side of the engine house, and large cargo ports on each side, two forward and two aft. These gangways greatly facilitated supervision, and permitted of an extension of the shop work from stem to stern, all on one deck, to be fitted up and thereafter known as the "shop deck." The cargo ports admitted much needed light and fresh air; and from steam launches and ship's boats, supplies and repair work were received and delivered through these ports, at about two feet above the load water line.

From the standpoint of equipment, the key to the Vulcan's success as a floating repair shop is to be seen in the selection and

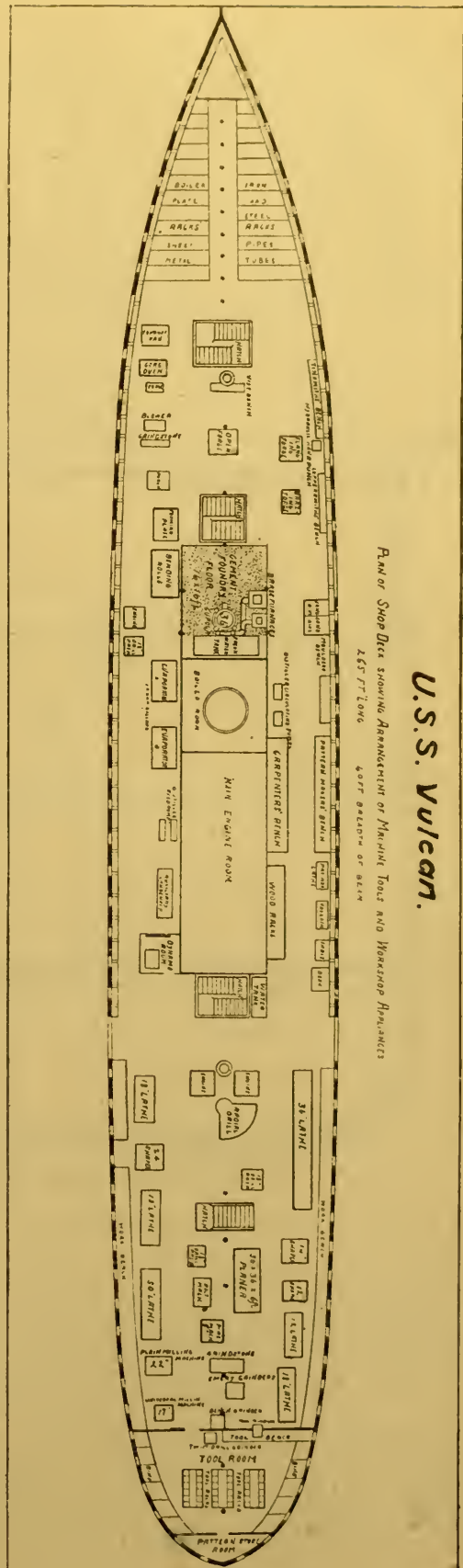


FIG. 1. PLAN OF SHOP DECK, U. S. S. VULCAN.

the arrangement of the machinery on the shop deck. No method of arranging shops on shore would apply at sea. No convenient wings, ells, or tees could be run off from a central shop system. No gallery plan could be adopted. The fore-and-aft arrangement of everything was necessitated by the rigid requirements of having all work on deck, as near the water's edge as possible, facilitating receipt, execution and discharge of work, with convenience of supervision, giving ready command of the whole work of the shops.

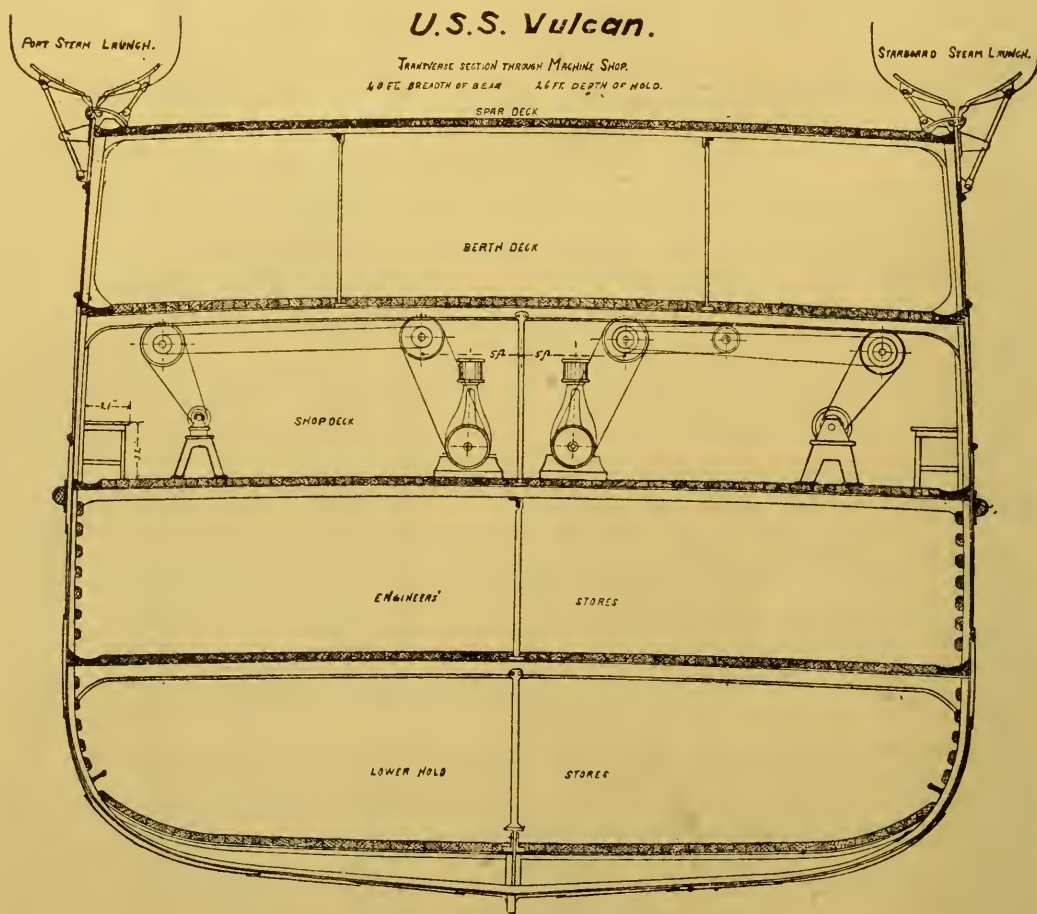


FIG. 2. TRANSVERSE SECTION THROUGH MACHINE SHOP.

The final arrangement of the shop deck is shown in Fig. 1. Racks for pipes, bar stock, sheet metal and plates extended about forty feet forward from the fore hatch. The boiler, forging, brazing, and foundry work were provided for in the vicinity of the forward cargo ports, for light and ventilation, occupying about fifty feet of the space between the engine house and the foremast. The pattern shop and the distilling plant were placed in the starboard and port gangways respectively, amidships of the engine house.

The administrative centre of the shop deck, so to speak, the superintendent's office and the foreman's headquarters, or in naval parlance, the headquarters of the officer in charge and of the officer of the day, were located by the starboard cargo port, abreast of the mainmast. Fig. 12 shows a view of the machine shop, from this point, looking aft. The machine shop extended about fifty feet aft of the mainmast to the tool-room, from the delivery window of which the view shown in Fig. 13 was taken, looking forward. Work benches were placed in the tool-room and on each side throughout the whole length of the machine shop, outboard of the machines, as well as along the pattern shop and brazing forge.

The three steam engines driving the shop machinery were of the simple, single-cylinder vertical-inverted plain slide-valve type, and were located as shown in Figs. 1 and 2.

TABLE OF SIZES AND POWERS OF SHOP ENGINES OF THE VULCAN.

Where located.	Size of Cylinder.	Horse Power	Diam. of Wheel.	Shafting Diam.	Driven Revs.
Machine Shop Starboard	9 x 9	20	36	2 7-16	200
Machine Shop Port	7½ x 8	12	36	2 3-16	225
Boiler Shop.	7 x 7	10	30	2 3-16	250

All main-line shafting was run fore and aft. Throughout the length of the machine shop, two lines were extended, five feet each from the centre line of the ship, and parallel to it. Similar lines of shafting were extended forward on the starboard and port sides of the engine-room house, and driven from the machine-shop lines respectively. To obtain as great a length of belt as possible, the counter-shafts were carried well outboard; and connected to the machines with oblique belts. The same feature will be seen in Fig. 2, with regard to the main driving-belt of the shop engines.

The head room was 7½ feet between the shop deck and the deck beams above. Belts from line to counter-shafts and all other athwartship belts were in the way of standing erect under them, but did not seriously interfere otherwise with working the machine tools. This available head room below belting varied somewhat according to circumstances, but the projecting adjusting screws of the hangers proved much more exasperating. Officers and men, however, became accustomed to dodging both.

The installation of the forge blower and hot-air exhaust system is shown in Fig. 3. The former was a "Monogram" Sturtevant blower, with 7-inch discharge driven from the forward line of

into the night, much to the discomfort of the men, who were trying to get some sleep and rest before another day's work. In iron casting not more than one heat was run off in a day and that usually about 3 o'clock in the afternoon. For after filling the moulds and dropping bottom, it was practically impossible to do much more in that part of the ship till the next morning. Kipling has sung for the Scotch engineer and stoker, but there was no heaven-born genius on board the Vulcan to treasure up the memories and scenes incident to dropping bottom. The usual luxuries of such work ashore were entirely missing. Like the fiery furnace of old, the heat seemed seven times more intense than it was wont to be ashore.

The foundry floor was made by cutting away the three-inch wood planks of the shop deck to the steel deck-plates below, laying down one-half inch asbestos board and then filling in to the original level of the deck with concrete, mixed in the proportion of one part of Portland cement to one and one-half of sand. Directly beneath the cupola a fire-brick floor was laid in cement on the asbestos board, and a cast iron foot piece placed in the center to receive the bearing bar of the cupola bottom. It was rarely possible to get all of the flasks on such of the space as might be available of this

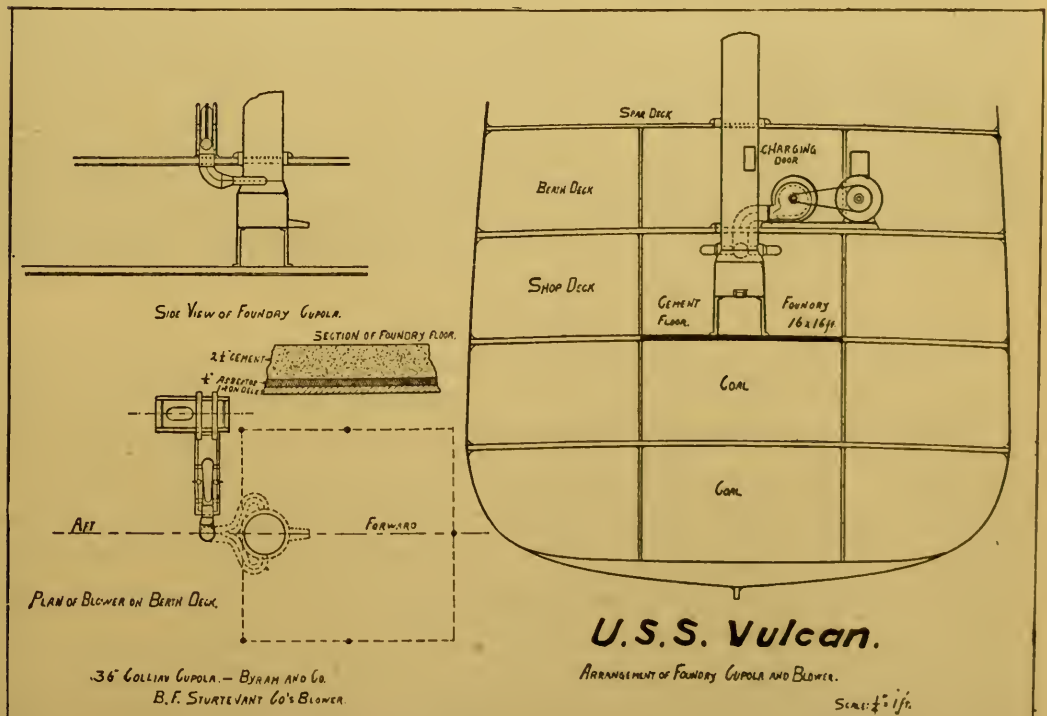


FIG. 4. ARRANGEMENT OF FOUNDRY CUPOLA AND BLOWER.

16 x 16 foot foundry floor. Many of the moulds had to be poured on the wood deck surrounding it, a liberal supply of water and of wet sand being kept in readiness for any emergency.

The cupola had a melting capacity of from 3,000 to 4,000 pounds of iron at one heat, or a rated daily capacity of five tons, being 27 inches inside diameter. It was charged from the deck above the foundry floor, as shown in Fig. 8. In the same view will be seen the No. 5 Sturtevant cupola blower, supplying an air blast through 9¾-inch discharge pipe, of from 4 to 12 ounces pressure, according to circumstances. The time required to blow up for a heat was usually about forty-five minutes, from turning on the melting blast till pouring ceased. Whenever the cupola was operated fire pumps were kept running, and men stationed at the fire mains with hose and buckets ready for any emergency. On the spar deck and topsides bucket men were also stationed, to guard woodwork, rigging, sailcloth, etc., from the sparks of the cupola blast.

There were two brass furnaces, 12'' x 12'' and 16'' x 16'', inside lining, respectively, located on the foundry floor, on the starboard side of the cupola, as shown in Fig. 9. They had each a separate stack, placed aft of the cupola and extending a short distance above it. The total height of all of these stacks was about 33 feet above the foundry floor.

The intense heat from the brass furnaces and stacks, and from directly over the cupola tap hole, proved the most difficult problem with which we had to deal in this part of the Vulcan's equipment. The whole wooden deck above the brass furnaces and the foundry floor was protected by asbestos board, overlaid with tin. Sheet iron was placed between the deck-beams above the tap hole, giving about eight inches of clear space between it and the wooden deck above for the free circulation of air.

A heavy covering of asbestos was placed around the brass furnaces and the foundry cupola. In the latter case it was extended from the bottom of the 37-inch shell of the cupola to the topsides of the ship. The stacks of the brass furnaces were lined with cylindrical fire-clay pipe, with cemented joints throughout their whole length. Free circulation of air was allowed around all of these stacks by cutting away the wooden decks and fitting with ample coamings. This proved entirely satisfactory for the cupola. It was found necessary, however, to open up more and more the air space around the brass furnace stacks. The horizontal and inclined portions of these stacks, just below the berth deck, were

provided with heavy asbestos coverings to further protect this deck from the excessive radiation of heat.

The engineers' stores comprised the finest and largest assortment ever put aboard a naval vessel, having been selected with great care for the specific work of the Vulcan as a repair and supply ship. They were placed below the shop deck, in specially-arranged store-rooms and bins, accessible from the after hatch and from that provided in the centre of the machine shop. The pig iron, anthracite coal, heavier stock of iron and steel stores, and



FIG. 5. U. S. S. VULCAN FITTING OUT AT BOSTON NAVY YARD.

barrels of oil were stowed in the lower hold aft. The fore part of the ship, below the shop deck, was also specially fitted out for engineers' and ship's stores, and for carrying increased coal supply.

Incandescent lamps were fitted throughout, in store rooms and on the shop deck, in addition to those which had been originally installed, and arranged to suit the conditions of the work. Three long-burning enclosed arc lamps were placed in the machine shops. With glaring forge fires and brilliant arc and incandescent lights, we were no doubt nightly exposing ourselves to Spanish Mausers off in the mountain passes and lying low in the rifle pits around the shores of Guantánamo Bay. The first night of our work we were ordered to put out all lights. It soon became apparent that the



FIG. 6. U. S. S. VULCAN IN DRY DOCK AT BOSTON NAVY YARD.

Vulcan would never get through with the work unless allowed to work at night.

The distilling plant was located forward, as shown in Fig. 1, and had a capacity of 10,000 gallons of fresh water daily. The

value of this at such a time and in such a climate, with skilled mechanics required to perform the work of the Vulcan nine hours a day 'tween decks, can not be over estimated. We were not only able to supply ourselves at all times with this commodity, but frequently gave large supplies of distilled water to the United States Marines, on Camp McCalla, as well as to ship's crews coming into the harbor for this and other supplies.

The examination and enlistment of skilled mechanics, to serve for one year, progressed rapidly while the Vulcan was fitting out at the Boston Navy Yard. Their highest rating was that of Chief Machinist, paying \$75.00 monthly, with an allowance for rations of \$9.00 monthly. Almost all of these men were quartered in the staterooms on the spar deck and in a portion of the original saloon of the steamship Chatham. Other enlisted machinists and workmen of lower rating than Chief swung in hammocks on the berth deck with the ship's crew. All of the men from Massachusetts received, in common with other volunteers from the same state, an additional sum of \$7.00 monthly during their term of service.

Work in the navy yard was at once organized for the newly-enlisted men, as seemed best adapted to bring out their several abilities, and in the various shops, according to the work required for the Vulcan. This served a double purpose—the work of fitting out was greatly facilitated, and we learned to a certain



By courtesy of Collier's Weekly.

FIG. 7. U. S. S. VULCAN WITH FLEET AT ANCHOR IN GUANTANAMO BAY.

THE NAVAL REPAIR SHIP VULCAN.

extent, before setting sail, what to expect of the men. The personnel of the working force of such a ship was a vitally-important question. The men enlisted from all conceivable motives. Few had ever been to sea before. Probably not one had ever been engaged in naval repairs at sea. Scarcely any of them knew their own resourcefulness till it was put to the test, a thousand miles from their typical New England workshops and quiet homes. With characteristic American genius they early adapted themselves to the new environment, took hold of the work with a will, were anxious to make things go, and were withal ambitious to excel. The great majority of the Vulcan's volunteers were in for whatever might be ahead. They had enlisted for better or for worse; had left happy homes and better paying positions; and were fired with an enthusiasm born only of love of home and native land. They enlisted neither to shoot nor to be shot. Non-combatants in the strictest sense of the word their work was to be wholly constructive rather than destructive. It would have dispelled the hopes of perhaps a few had they known that they were not going on a summer pleasure cruise, or were little likely to have a picnic—that in fact

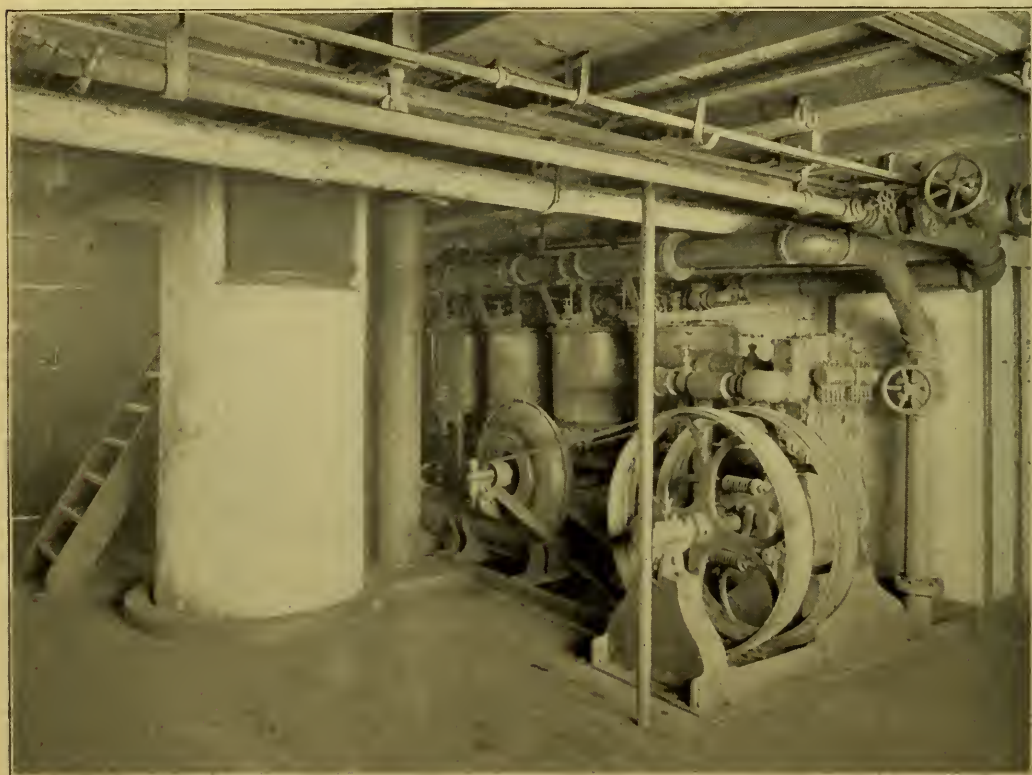


FIG. 8. VIEW OF FOUNDRY CUPOLA AND BLOWER ON BERTH DECK.

there would be four months of the hardest kind of work ahead of them, riding at anchor in Guantánamo Bay.

The enlisted men of the shop force were of the most varied attainments. Among them were graduates from colleges and technical schools, doctors, dentists, engineers, machinists, skilled and unskilled workmen from all the walks and stations of life, equal in such a representative capacity to the Rough Riders ashore. It was singularly fortunate that some of them were of such abilities as to adapt them to quite a wide range of most helpful service in executing the work of the Vulcan's program.

After many days we had learned by experience the specialties of all of the men. Only then was it possible to assign them to work and duties for which they were more or less thoroughly adapted. The following classification is not according to navy enlistment papers of these men, but according to their several abilities as determined after two months' experience with them:

Machinists,.....	39	with 11 helpers.
Boilermakers,.....	25	" 2 "
Blacksmiths,.....	5	" 2 "
Coppersmiths,.....	5	" 1 "
Pipe-fitters,.....	4	" 3 "
Moulders,....	4	" 1 "
Electrical Machinists,.....	2	
Pattern-makers,.....	3	
Carpenters,.....	2	

Summary: Workshop force,	89	with 20 helpers, 109
Engine and Fire-room detail,.....	30	
Engineers' Yeomen,.....	2	
Cooks, ...	7	
Ship's Crew of the Vulcan,....	70	
Total,.....	218	

A ship fitted out at a navy yard, it has been said, is never ready for sea, and the Vulcan was less likely to be an exception to the rule than any other vessel of the auxiliary navy. It was like fitting up and starting a new manufacturing establishment. A hundred things seemed to demand attention at the last moment. But the day and hour were fixed, perhaps with a divine prescience, but with a certainty that as the long days of June wore on it became more and more probable that Cervera would try to make his escape. As it was, the Vulcan reported to Admiral Sampson just forty-eight hours before the famous *sortie*.

At sea, a part of the shop force was divided into three watches, similar to that of the engine room detail, and the remainder was assigned to the regular deck watches. Throughout the twenty-

four hours work was carried on in the shops and store rooms of the Vulcan, to finish the many little details of interior fittings and arrangements, and systematize everything for the first call to duty. If anything in the late war anticipated the new Navy Personnel Bill, among the enlisted men, this manning of the Vulcan at sea seemed to foreshadow it. All hands had something to do, and they did it, with an adaptation and a resourcefulness truly characteristic of the American mechanic.

The Vulcan arrived off Santiago de Cuba just in time to witness the operations along the shore of Aguadores, three miles east of Morro Castle. General Shafter's line of investment extended from Aguadores to El Caney, forming a battle line about six miles long. At Aguadores the Spaniards held the old stone fort near the western end of the railroad bridge, which they had wrecked earlier. General Bates held the extreme left of the line of investment, terminating at the signal house at the eastern end of the railroad bridge. The 33d Michigan, under General Duffield, had just arrived on the Harvard, the convoy of the Vulcan from Newport News. They were landed at Altares and brought to the front along the shore by the



FIG. 9. VIEW OF FOUNDRY EQUIPMENT ON SHOP DECK.



FIG. 10. BOILER SHOP AND FORGE DEPARTMENT.
View looking toward port bow.

line of the railroad, advancing toward the bridge under cover of the fire from Admiral Sampson's flagship, and the gunboats, Suwanee and Gloucester. Three shots at the old stone fort were requested and allowed the Suwanee. The first, tore the Spanish flag; the second, struck the flagstaff; the third, shot away the staff and the flag, and exploding scattered the Spaniards in all directions, and demolished the old fortification, sending its ruins rolling down the embankment like a landslide.

There were two six-pounders forward, and we tendered our services to Admiral Sampson. He reminded us that gunboats and battleships would do the fighting, if there was any to be done, while our sphere of activity was elsewhere. After reporting to the Admiral the Vulcan stood towards the shore, almost under the brow of Morro, so close, in fact, that the Admiral signalled the Massachusetts to bespeak the Vulcan as she rounded to, to keep farther off shore. The Vulcan changed her course, bespoke Captain Philip, of the Texas, as he was wetting down decks and clearing ship for action, and returning farther out to sea, bespoke the Newark, and left the scene of action for Guantánamo Bay. This was the first, the last, the only smoke of battle enjoyed by the Vulcan.

THE NAVAL REPAIR SHIP VULCAN.

Guantánamo Bay possessed every advantage for a naval base, almost land-locked, with broad and deep channels, shoal waters for smaller vessels, good beaches for bathing and for landing parties, fine fishing, and an inexhaustible supply of fresh water from the Guantánamo River, navigable for fourteen miles, and emptying near the mouth of the bay.

The cable from Caimanera to Mole St. Nicholas was early cut by the Americans at a point between Caimanera and the "Playa," or the cable station at Fisherman's Point. Having established Guantánamo Bay as a naval base, the government made use of this cable station for all dispatches. It was equally used by the newspaper correspondents, but at times, of course, was completely cut off from such use. In the evening of July 3, for instance, Washington was receiving army dispatches of quite recent events about Santiago and the correspondents could not avail themselves of this cable for news to the States as to the disposition of Cervera's fleet. The cable was repaired later on and government messages thereafter sent from Caimanera. The Vulcan afforded facilities to the cable staff in the electrical work of repairing the cable. The cable house is built of corrugated iron, lined with wood, with two shot holes for ventilation and sight seeing—

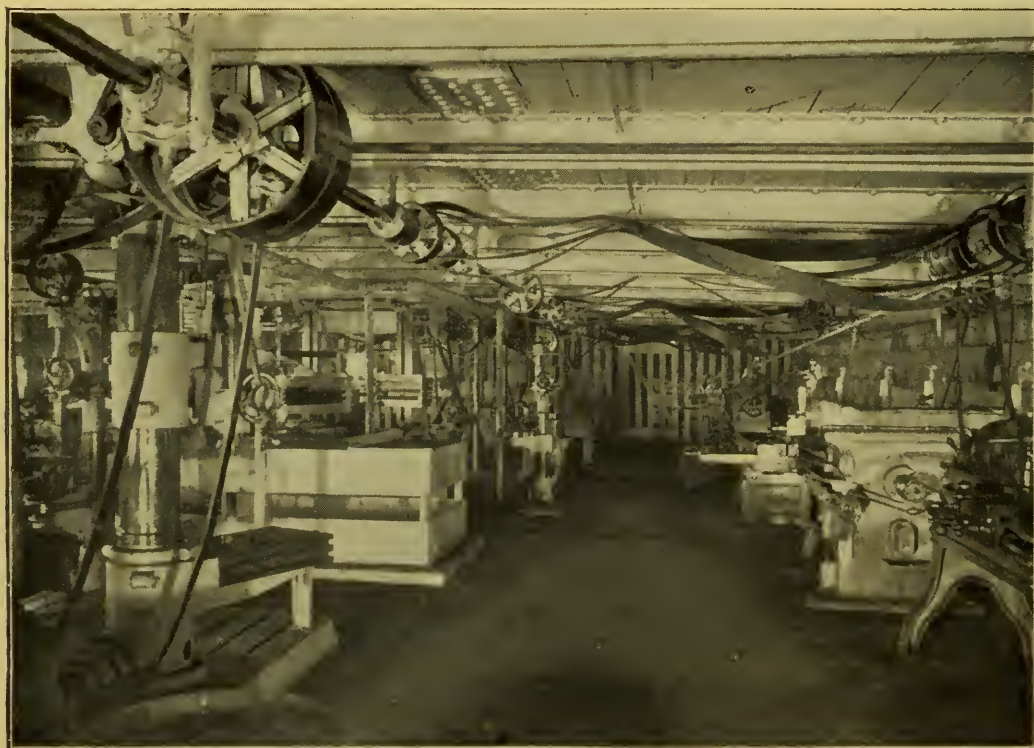


FIG. 11. MACHINE SHOP. PORT SIDE, LOOKING AFT.

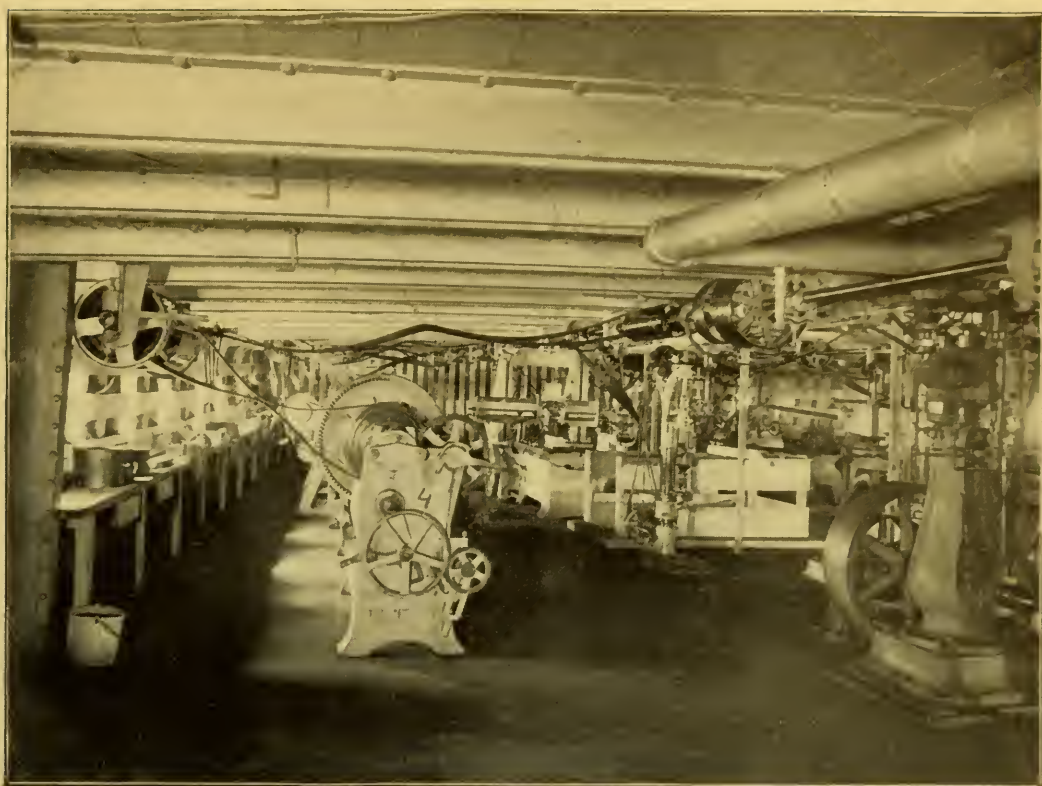


FIG. 12. MACHINE SHOP. STARBOARD SIDE, LOOKING AFT.

souvenirs of the struggle in establishing this point as a naval base, June 10-12, 1898. To the rear of it are the remains of an old-time Spanish homestead, with walks and orchards of palms laid out with taste.

The division of the working force into three shifts was maintained only so long as it was absolutely necessary in order that the early rush of work might not accumulate. Those men who were obliged to rest and to sleep at night could get very little of either on account of the noise and the lights. Those obliged to sleep in the daytime fared no better, with noise and disturbances on every hand. The conditions surrounding the men on board the *Vulcan* were as different from those on a regular naval vessel as could well be imagined. Of course, the work goes on, but long lines of shop shafting, blowers, and hot forges with the accompanying noises of work in forging, boilermaking and machine shop, are not kept in full operation seven days of the week throughout the twenty-four hours. There was no place for the men to rest—no rendezvous, such as they had been accustomed to on shore. The work was continuous, for eight or nine hours, or more, as necessity demanded,—quite different from the customary four hours on duty and

eight hours off in the regular service. As soon as possible, therefore, the men were divided into two shifts, giving all hands eight hours of rest and quietness.

The regular day's work of nine hours was established as soon as possible, from 6:45 to 11:45 A. M., and from 12:45 to 4:45 P. M. The fifteen minutes was allowed at the close of each period to give the men time to wash up and get ready for the next meal, set for the even hour, as usual on board ship. The men were called at 4:30 or 5:00 A. M., according to the season, giving ample time to



FIG. 13. MACHINE SHOP. STARBOARD SIDE, LOOKING FORWARD FROM TOOL ROOM.

wash all clothes, prepare their quarters and staterooms for the daily inspection at 9:00 A. M., and engage in other early morning work of a naval vessel. All hands were called to quarters, at 6:00 P. M., daily, except Sundays, and "taps" were sounded at 9:00 P. M. Fire drills and "abandon ship" were occasional exercises.

All orders for repairs or supplies were received at the starboard gangway, with the accompanying requisition, after being approved by the commanding officer of the Vulcan, Lieutenant-Commander Ira Harris, U. S. N., and endorsed "O.K." by Chief-Engineer James H. Chasmar, U. S. N.

Shop orders were written out for the repairs or the supplies and sent to the heads or chiefs of the respective shops, according to the kind of work called for. These orders were returned with the finished work, to the shop headquarters, with the workman's time noted thereon when required. Entries were made of the same, and the work delivered from the port gangway. A daily journal was kept of the character and extent of all repair work.

Assignments to duty were made each morning and noon hour, in the case of men not otherwise detailed, or such as might be

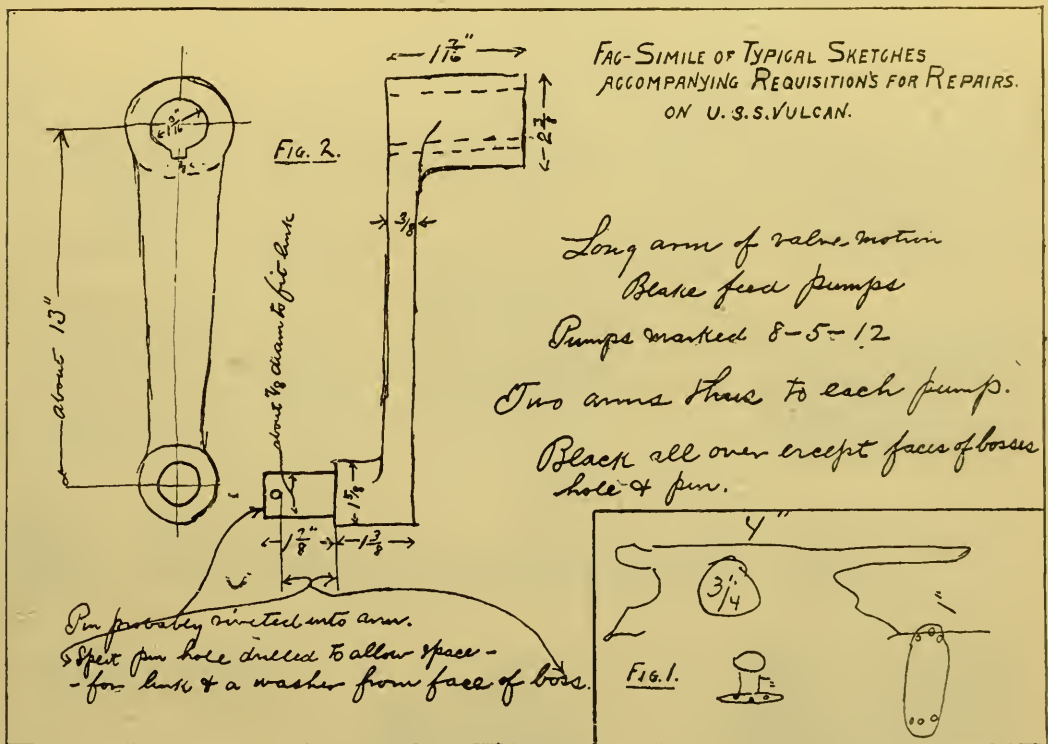


FIG. 14. FAC-SIMILE OF TYPICAL SKETCHES ACCOMPANYING REQUISITIONS FOR REPAIRS.

required to leave the Vulcan for work on other ships. Steam launches took the latter parties, at 7:00 A. M. and 1:00 P. M., and called for them again in time to return for meals on board the Vulcan.

All tools required by the workmen, either for use on board the Vulcan or some other ship were delivered from the tool room, on the workman's request, and his signing for them. All stock and material which workmen might require were delivered from the store rooms only on written order and requisition of an officer, usually on the order of the engineer officer on duty on the machine shop desk.

Sketches accompanying requisition were sometimes very meagre, while others were detailed enough to gratify the most fastidious mechanic. The productions, shown in Fig. 14, represent two types of drawings, sufficiently far apart in merit and usefulness to include almost all of the other kinds between these extremes. In a few instances, however, blue prints and carefully executed pen-and-ink drawings were furnished with the requisitions for repairs.

The group of patterns, Fig. 15, is thoroughly representative of the wide range of work called for in the line of brass castings.

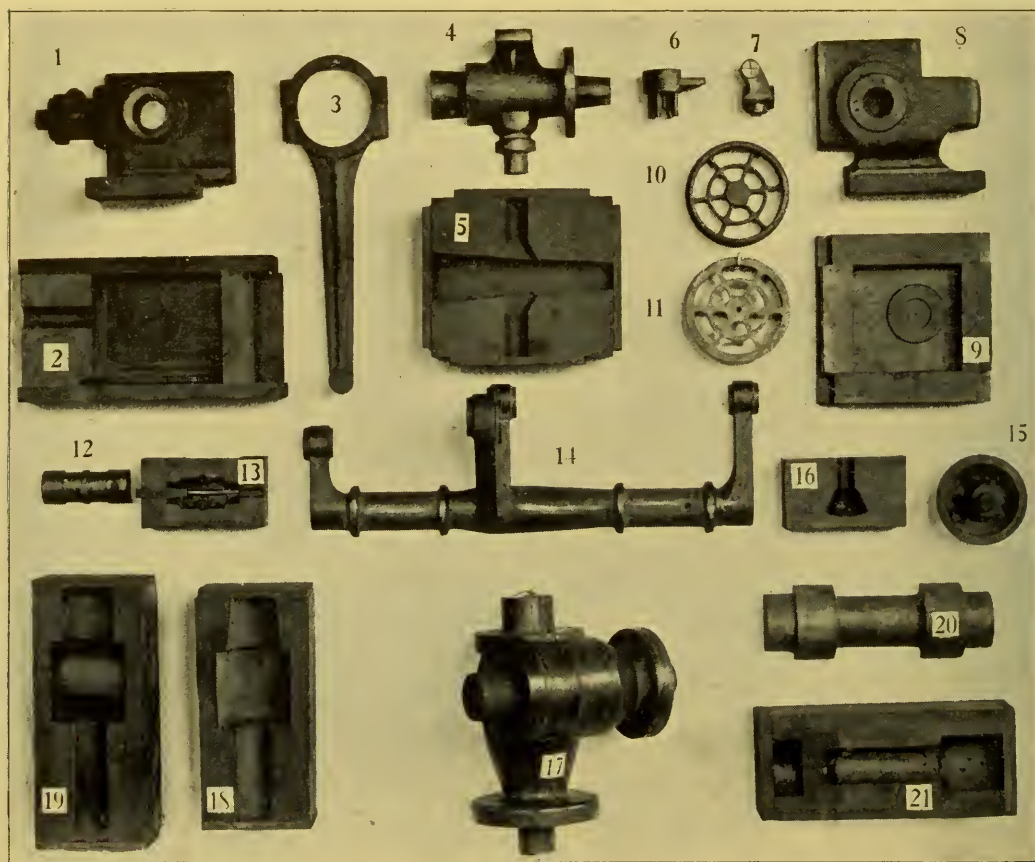


FIG. 15. GROUP OF TYPICAL PATTERNS FOR CASTINGS AND REPAIR WORK FINISHED ON BOARD THE U. S. S. VULCAN.

1, 2; Pattern and Core Box for Crosshead of Ice Machine, U. S. S. New York. 3; Pattern for Eccentric Rod and Strap for Willan's Dynamo Engine, U. S. S. Gloucester. 4, 5; Pattern and Core Box for Plug Cock, for U. S. S. Oregon. 6; Pattern for a small valve, to be fitted with loose stem, representative of large class of repair work. 7; Pattern for Rod Clip of Auxiliary Pump, U. S. Torpedo Boat Rodgers. 8, 9; Pattern and Core Box for Dynamo Engine, U. S. S. Massachusetts. 10, 11; Wood and Metal Pattern for Valve Seats, U. S. S. New York. 12, 13; Pattern and Core Box for Supplementary Steam Valve, for Auxiliary Pump, U. S. S. Indiana. 14; Pattern for Rock Shaft for U. S. S. Helena. 15, 16; Pattern and Core Box for Valve, for U. S. S. Newark. 17, 18, 19; Pattern and Core Box for Double Valve, for U. S. S. Vixen. 20, 21; Pattern and Core Box for Hydraulic Piston, for U. S. S. Indiana.



By courtesy of McClure's Magazine.

FIG. 16.—THE DAMAGED ARMOR HATCH OF U. S. S. IOWA.

Repaired by U. S. S. Vulcan.

Perhaps they illustrate methods of pattern-making and seem to dictate moulding practice slightly at variance with established rules, but the conditions under which they were rushed through must be kept in mind. The core boxes seem to show rough-and-ready construction, but these had to be at hand when the patterns were finished. The pattern and core boxes for the double-valve of the Vixen, (17, 18, 19), for instance, were made at one stretch, without

rest or sleep for the pattern-makers, till all was ready to hand over to the moulder.

The pattern for the valve-seats for the New York, (10, 11) was made from a carefully-executed pencil sketch, furnished the Vulcan. The pattern for the rock-shaft for the Helena (14) was made from a blue print, also furnished for the purpose. All of the other patterns shown in Fig. 15 were made from the original articles sent aboard the Vulcan as samples, and this was the usual practice followed in making patterns for such new parts.

White-metal patterns were made frequently from the first wood pattern, when several spare parts were ordered. This is shown in the case of valve-seats for the New York (10, 11), of which a requisition for thirty-six was filled. The requisition for the plug cocks for the Oregon (4, 5), called for nine castings only, to be afterwards finished by the machinists of the Oregon in their own shops; and these were not to replace any broken parts. A six-inch Spanish shell had penetrated the Iowa, on the starboard bow, a little above the water line, and exploded about 12 feet inboard, where it struck an armor hatch on the berth deck. Fig. 16 shows the erratic course of the fragments. There were at least three hundred holes in the thin steel deck and bulkheads in the vicinity of the explosion. Fragments of the shell passed through, as the armor hatch was blown off, and started a fire on the protective deck below. The Vulcan made an entirely new hatch cover and coaming with all fastenings, and trimmed around the ragged edge of the deck, and inserted a new piece of plate.

Submarine mines were quite thickly located in the upper portion of Guantánamo Bay between Caimanera and the fort opposite. Launches from the Marblehead and Dolphin began searching these upper channels, and finally thirty-nine were removed and safely placed on the adjoining shores and beneath the old fortification opposite Caimanera. The Texas struck one, and took it aboard as a trophy. These mines were put down recently, some of them as late as April, 1898. All of them were contact mines, but none were in perfect order, as they were repeatedly struck by the propeller blades of the Texas and Marblehead. It requires 40 pounds pressure to explode the cap upon which the firing pins are pressed by the contact hooks, of which there are six. In the one brought aboard the Vulcan and taken apart, the charge consisted of 117 pounds of wet guncotton. These mines are about 30 inches across the top and 36 inches high, built of light boiler plate, and

having the charge of guncotton in a cylinder of 12 inches diameter.

The furnaces of several of the boilers in at least two of the ships of Admiral Sampson's fleet were very badly bulged, or, as it is called, down in the flat (cylindrical) portions and in the corrugations. This appeared to be a natural result of the necessity of using salt water on blockade duty off Santiago. A ship with several boilers often might spare one to be connected up as an evaporator, and by thence running a large pipe to the main surface condenser, form a satisfactory, though temporary, distilling system. This alone was not sufficient in most cases. The daily loss of fresh water on such blockade duty was far greater than the supply. Off Santiago

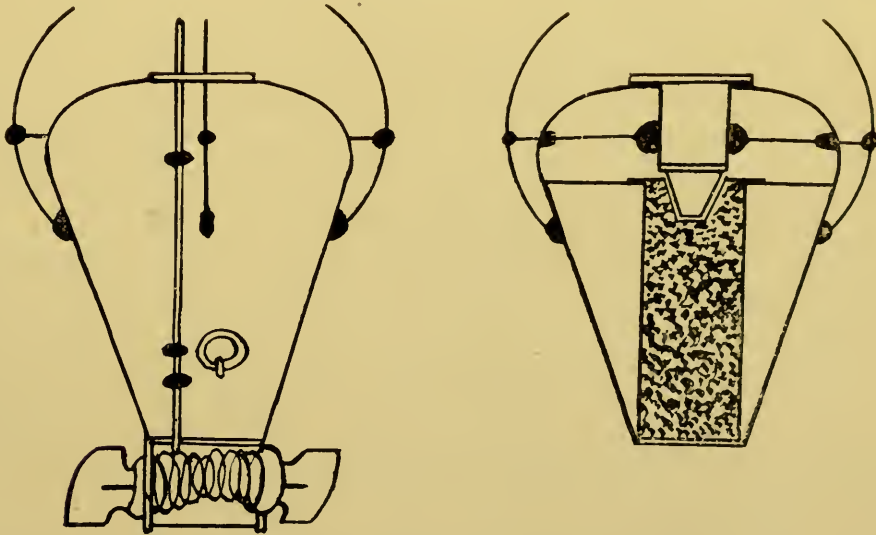


FIG. 17 SPANISH SUBMARINE MINE FROM GUANTANAMO BAY.

Taken apart on U. S. S. Vulcan.

no anchorage was possible, the ships being more or less under steam all of the time, and such arrangements outlined above proved insufficient. Salt water had to be used in the boilers of several of the vessels to make up this loss to a great extent. In time this resulted in over heating and bagging the furnace crowns.

To jack the furnace crowns back into their original positions, cast-iron formers were molded and finished on the Vulcan and fitted to the shape of the crown or corrugation, as the case might be. That portion of the furnace-crown requiring to be jacked up was then heated to a cherry red by an improvised charcoal furnace placed underneath and supplied by hand or electric blower air blast. While at this heat it was readily jacked up into the former natural

shape and allowed slowly to cool. The excellent quality of the mild steel boiler plates used in these naval vessels made this work entirely feasible without seriously or permanently impairing the strength of the furnaces.

The Vulcan's part in the war was entirely constructive—portions of machinery were made on board the Vulcan to replace that broken or disabled in duty or in action on the other ships. Besides the larger part of the work done for the Steam Engineering Department of several of the vessels, extensive repairs were made for the Equipment, Navigation, Ordnance and Construction departments. Thorough overhauling and repairs were made for the different vessels of their main engines, reversing or jacking engines, capstan engines, winch engines, crane engines, blower engines, steering engines, dynamo engines, dynamos and electric motors, ice machines, steam pumps of various types, main and auxiliary steam boilers, and extensive repairs made to boilers, engines and pumps of steam launches. A large amount of repair work consisted in refitting and re-arranging piping systems, both iron and copper, and in making and repairing numerous copper pipes. Steam gauges were standardized. Electrical fittings on many of the ships were altered for more convenient distribution. Manufacturing orders were executed for many spare parts, such as air-pump valve-seats, ash-hoist castings, plug cocks, wrist pins of small engines, special studs and screws, special spanner and socket wrenches, reducing hose couplings, blank and ring flanges, check valves, valve-stems and bushings.

Many new brasses, piston rings, pistons, cylinder covers and rods were made for auxiliary engines and pumps.

It may be interesting to note that the vessels of the auxiliary naval force required, in general, a different type of repairs from those of the regular navy. That is to say, repairs were frequently called for by the auxiliary vessels in order more thoroughly to adapt them to the new conditions of the naval service and calling therefore for many changes and alterations other than those required by direct repair work. In general, the following classification of repairs included almost all cases:

- (1.) Repairs due to structural weakness.
- (2.) Repairs due to hard service and rough usage.
- (3.) Repairs required by maltreatment in service.

Requisitions for supplies not on hand were filled, in many cases, by manufacturing the required articles from raw material in the stock

carried by the Vulcan's stores. Among these particularly were large orders for special bolts for gun mounts, brass screws for condensing and distilling apparatus, and in some cases special brass pipe castings and fittings were made.

In the line of ordnance work, gun mounts were made for the new six-pounders sent down to be mounted on the small converted yachts, alterations were made in old gun mounts, new foundation plates were made for others; and in one case an entirely new bronze casting was completely finished for replacing a cracked gun-mount bracket. Firing pins, gun springs, etc., were made to replace broken or damaged parts and detent triggers of turret guns fitted with new steel blocks.

In the line of equipment and construction work for the different ships, the most varied kinds were executed by the Vulcan's force, comprising orders for hammock hooks, boat hooks, cleats of various shapes and sizes, swinging booms complete, gangway ladder fixtures and fittings, ship's small boats overhauled and fitted out, new rudders, pins and pintles for small boats, anchor stocks, ring pins and shackles. The larger work of this nature comprised straightening out side plates with specially-made strong backs fitted out on the Vulcan, with deck and hand rail stanchions and repairs to anchor and boat davits.

In the first forty-one days of the Vulcan's work in Guantánamo Bay, there were 528 orders for repairs filled and 256 requisitions for supplies.

There was little to disturb the routine work of the Vulcan till the signing of the protocol. The Vulcan's steam launch maintained nightly picket duty, up the bay, towards Caimanera, and just below the fort opposite, and was fired on once or twice without effect. The French flag, by permission, was allowed to fly over the Plaza, on the fourteenth of July, in honor of the fall of the Bastille, seeing which a French man-of-war took courage and came into the offing of Guantánamo Bay, till brought to by a blank shot and two solid shots fired across her bows from the Marblehead. Pending the delay of the surrender of General Toral to General Shafter, the Spaniards became bolder, and a steam launch from the Marblehead picked up a straggling decoy on the beach, and received in return the fire from shore riflemen, concealed in ambush. The strain of the work reached the climax in fitting out the ships selected for the coast of Spain, when we learned of the signing of the protocol, Friday evening, August 12th. At 10:00 A. M., Sunday, August 14th, Admiral Sampson set sail for New York, with all of the battleships.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

VI.—COMPARISONS AS TO EFFICIENCY OF MACHINERY AND METHODS.

COMPARISONS are odious, but they are frequently instructive. The engineer should be cosmopolitan. If in any particular case his work is superior to that of others, he should know the weaknesses of his rivals and avoid making the same mistakes. On the other hand, if sufficient evidence is offered to indicate that he is not up to date, he should certainly want to know the why and wherefore. A fair comparison as to mechanical progress is desirable for both sides—European and American.

It is usually admitted by those who have had the opportunity of making comparisons, that America leads the world in machine tool design, and in the economic employment of mechanical methods. At the same time, there are many things accomplished in European workshops that would surprise those Americans (not by any means a limited class) who have an unduly exalted idea of the greatness and superiority of all that is produced in their own country. There is nothing in America that excels some of the manufacturing establishments I have visited in England, either in equipment, organization or quality of product. I hardly think any American manufacturer turns out such a monument of mechanism as the English loom makers will supply for \$150. The marine engineering work of England is the admiration of all mechanics, and the wonder of the American who employs different methods for producing this class of work. Some of the locomotive works of England are splendidly equipped and do good machine work, although their plants are not as a whole so up to date as those of the American establishments. I have never seen anything in America superior to the work turned out of the German small arms factories, considering quality, finish, and cost of product. It is unfair to make comparisons without duly considering surroundings and history. The state of the machine tool art, like other industries in America and Europe, has been mainly shaped by economic conditions. What those conditions are, and how they have operated, it is beyond the scope of this article to discuss. It is sufficient to

state that in America the tendency is to reduce all production to machine operations. In European countries the tendency is to employ machinery as an assistant to production, and to rely on skilful hand labor to complete, and in some cases to produce outright, the highest grade of work. The consequence is that we find in America the highest skill and talent devoted to the production of machinery on which the article is made, and in Europe the highest skill devoted to the production of the article itself. As far as talent is concerned there is as much on one side of the Atlantic as on the other; it is simply progressing on different lines.

Warner and Swasey, the well known makers of machine tools and observatories, formerly sent to Germany for all their fine levels used in astronomical work, although they are now able to get them in America. I am told that Reichel, a German maker, has one in his workshop so delicate that it indicates the deflection which takes place when pressing against the walls of the room. His levels are purely a product of specialized, skilful hand work, in which the Germans in many instances excel. It is done with the care and pride of an artist, who repeats the same painstaking operations on every piece of work he produces. The spirit and influence of the old craftsman is not dead in Europe. It lives in nearly every industry. Tedious and costly hand work does not seem to worry the European as it does the American, who is never satisfied with producing by hand if he can invent a machine or appliance for doing the same labor. A good example of a pure Americanism is found in the works of this same company which sent to Europe for its fine levels. Warner and Swasey have been for several years developing a graduating machine which for accuracy and delicacy is probably not to be found in any European machine shop. It is interesting to note that at the time that I saw this machine it was in charge of one whose speech had the strong accent of the Fatherland. The machine is for automatically graduating the degrees of a circle, and is so sensitive that the heat from the human body destroys the accuracy of its work if it should be operated by hand. The part is inserted, the machine set in motion, and no one allowed in the room until the work is completed, when the machine stops automatically. The apparatus is not only a splendid example of design and workmanship but also of the trouble, expense and study of detail to which the American will go to avoid the tiresome repetition of hand operations. The spirit which prompted its conception is the same that is moving the American

to invent the automatic machinery and labor saving devices, for which he is noted. It is the spirit which is lacking in European industry. The important question is: by which method, the European or the American, is the greatest industrial progress possible? I shall attempt to deal with methods, tendencies and general characteristics which directly interest the maker and user of machine tools, and not to go into detailed comparisons as to the relative merits of machinery, which could not be properly undertaken, except in the form of a treatise.

Although machine tools of all classes are produced by European makers with the full complement of automatic movements and labor saving attachments, the use of such machines is by no means common in European workshops. They are not demanded by manufacturers nor workmen. The result is that the usual catalogue machine of the European maker is lacking in the many handy devices and power movements almost invariably found in the regular article produced by the American maker. This is true of nearly every class of light machinery, but in the heavy millers and slotters the English maker is well to the front. In fact, some Americans frankly admit having copied the English design. At the same time, Americans are having good success in selling heavy machinery in Europe, easily competing in price and quality. With no trade union to dictate, and everybody working under high pressure, the tendency in America is to make movements automatic wherever it is possible; to use the automatic feed, in the lathe, the drilling machine, the milling machine, and to place one workman in charge of several machines which are so made that by the simple movement of a lever or by a couple of turns of a hand wheel everything is quickly made ready for the next operation. There is the greatest indifference amongst Europeans to the value of these minute and even second saving devices which are a marked characteristic of American machine tools. I have seen factories recently erected in England with an entirely new equipment in which there are rows of lathes, perhaps ten or twelve in number, without automatic feed of any description. The proprietor, when questioned as to why he ordered lathes without automatic feeds, says: "Oh, we are obliged to have one man to one machine anyway, and if he didn't have something to do he would go to sleep." This is not an extraordinary case but rather a common one. I have also seen in European factories employing thousands of workmen, in departments where literally millions of one particular

part are made, the most expensive operations performed with hand tools. The hand operations which are so commonly seen in European workshops are practically unknown in America. I believe an investigation would show that a large percentage of American imports consists of those goods which are largely the product of skilful hand work; articles which the American has not yet developed the machinery for making, or which cannot in any case be produced by machinery.

Not only in the development of automatic movements for the ordinary machine but also in the purely automatic machine is the American maker leading the European. Good examples of this are the automatic screw machine and the automatic gear cutter, both of which are being sold in large quantities to European manufacturers. It is remarkable that the automatic screw machine is not made to any extent by any of the large European machine tool makers, with the exception of the Loewe Co., in Berlin. It may be said to be purely an American product, and good machines are made by half a dozen well known firms. Its application is being extended every day, although the field for its usefulness is scarcely touched in Europe, bicycle work excepted. In the bicycle trade enormous orders have been given to American makers,—for 25 and 50 machines at once. It is almost invariably the case that these machines produce from 10 to 20 per cent. less in European shops than is turned out by them in American factories.

Although the automatic gear cutter is made by European companies, I should say that the sale in Europe of the American article is far in excess of the home product. This may be partly due to the fact that a large number of European manufacturers—many, machine makers themselves—still adhere to the cast tooth, arguing that it is stronger and when accurately cast, will wear much longer. As a matter of fact, it is rarely accurately cast, and the more perfectly formed cut tooth has much better wearing qualities than the usual imperfectly cast tooth gears with contacts only here and there. The cast tooth is sure to find a lively competitor in the tooth cut by the American automatic gear cutter, with feeds varying from 1" to 4" per minute, quick returns and automatic indexing. One operator can in many cases attend 6 machines.

The universal grinding machine in its perfected form is purely an American machine, and has been largely developed by the Brown & Sharpe Manufacturing Co. The full fledged universal grinder is a rarity in the average European workshop. It is

looked upon as a refinement beyond the requirements of the ordinary mechanical outfit, while in America manufacturing plants are hardly considered complete without them. There, its field is no longer confined to the "tool room" equipment and fine gauge work, but is extended to the manufacturing of cylindrical parts, which by its aid can in many cases be more cheaply and accurately finished than on the lathe manipulated by the most skilful "turner." It will surprise many manufacturers also if they investigate the possibilities of the grinding machine for finishing flat surfaces, taking the place of the file and hand polishing. Where one machine is used this will scarcely be cheaper, but when four or more surface grinding machines can be operated by one man the work is not only cheaper but far more accurate, and of better appearance than when finished by hand.

Another machine which, although probably made in some form or other in Europe before a machine shop existed in America and is still made by many European makers, is in its highest form and extensive use distinctively American, is the heavy turret lathe. I am referring particularly to the type known as the flat turret lathe made by Jones and Lamson, to the Gisholt turret machine, and those of other well known makers for turning out a similar class of work. The merits of both of the above machines are now so well known that it is not necessary to mention them here. The Jones & Lamson Co. state that their foreign business is keeping pace with the home trade, which is an indication that the machine is appreciated by European users as well as by American. In spite of their success there is but one maker in Europe who produces anything that can compare with the American machine, that is, Herbert, of Coventry. The Jones and Lamson and the Gisholt lathes greatly reduce costs of manufacturing parts that were formerly made on the ordinary lathe, and in many cases save from 50 per cent. to 100 per cent. As far as I have seen, the European manufacturer of brass goods is lamentably behind the American, for the simple reason that he has not made use of the completely developed turret tools which are common in America. The success of the American turret machine lies chiefly in the perfection of the tools. Rigidity and power can easily be secured in the machine itself. As in other cases, the product of the American turret machine in Europe is often 20 per cent. less than from the same machines when operated in America, even when the European user imports American material.

The chief reason, however, for the failure of the highly productive turret machine in European shops is the want of skilful, intelligent tool makers; men like those who in America receive from \$3 to \$4 per day, and even more, and easily keep a dozen complicated machines in running order, producing the utmost of which they are capable, and maintaining their accuracy day after day. Such men are the highest wage earners and the cheapest producers which a factory can secure. Judged by the American standard, they do not, as a class, exist in Europe. As before stated, it is not because skill nor ability is lacking in the European mechanic, but because his talents are working in other directions. The most skilful are too frequently employed in producing the article itself rather than in perfecting and maintaining machinery which can be manipulated by the unskilled operator and, in many cases, run at a speed that would give a paralytic shock to the jog-trot European hand worker.

That nation which is most advanced in the art of making and using machine tools is sure to lead in general manufacturing, and, conversely, those who lead in manufacturing must necessarily make use of the most highly perfected and accurate machine tools. In the maintenance as well as in the production of labor-saving machinery, Americans are naturally farther advanced than Europeans. Skilful labor is employed for this purpose, and manufacturing establishments are usually fitted with the best of machines and tools to be used solely for repairs and re-production of plant. Without such a department, jigs, fixtures and complicated, expensive, special tools can not be kept in an efficient condition. The failure of American machines to produce as much as they do at home is also partly due to the fact that European manufacturing establishments are but rarely fitted with good "tool rooms," with the universal milling machine, the universal grinder, shaper, accurate lathes, cutter-grinders, etc. A great deal of manufacturing is done in England and on the continent at a very low price, but it is in many instances of inferior quality, for no other reason than that the tools and fixtures are not properly repaired nor kept in order. Good facilities and the proper mechanical ability are not commonly employed. It is surprising to what extent even the simple appliances for keeping milling cutters in order are wanting in European manufacturing establishments. The milling machine is not used as extensively in Europe as in America, neither in respect to variety of work nor in the way of complicated and broad

cuts. When trying to introduce milling machines I have repeatedly been met with the statement that the original cost and maintenance of cutters would be so great that there would be "nothing in it." The simple and inexpensive planer tool would be largely superseded by the milling cutter in European shops, even where small quantities are turned out, if the care of cutters was more generally understood, and if the facilities for maintaining plant were looked upon as indispensable to good and economical manufacturing. It is the same with tools and fixtures as with machinery, even worse; the first cost is often proportionately so high that the cost of the article, which the machines and tools are made to produce, receives comparatively little consideration, no matter how much it may be reduced by the adoption of the proper machinery. European manufacturers may adopt all the Yankee machines they can buy, but if they continue to employ the cheap tools and primitive fixtures commonly in use and do not invest in more effective (though not always more complicated and expensive) tools, and if they do not have better facilities and higher class labor for maintaining these tools, they can not compete with the American manufacturer.

It is much easier to compare broadly European and American manufacturing plants than to contrast individual types of machines. The average American manufacturing establishment, with its full complement of machines, tools, fixtures, auxiliary plants and skilful labor, is far in advance of the average European. I believe it is also true that the average American machine tool is more effective than the European. It surely is in America, operated by American labor. It is, however, not always a success in Europe in competing with the home product, even when manipulated by a "native." The effectiveness of a machine is dependent on its design, on the operator, and on the material to be worked. European machines of certain classes will probably hold their own against the American for some time, for the reason that they are better understood by the operator and are better adapted to the available material. This would be especially true of the English lathe and turret machine. European cast iron, brass and steel are harder, and less accurate in form and size than the American article. More material has to be removed by the European, and its quality is less studied, with a view to cheap manufacturing, than in America. Cast iron is hard, rarely pickled or annealed to remove sand or scale, and is not so accurately moulded. Its composition

is not so carefully studied with a view to machining. Neither cast steel nor machinery steel is so accurately made to size, nor is the quality so well adapted to special purposes, in Europe as in America. I think in some cases American machine tool makers have gone too far in their efforts to secure a material that can be rapidly machined, and have made the machine less effective and less durable in their endeavors to make it cheap and still of good workmanship. This would be particularly true when making for the European market, where the machine is sure to get rough usage and has to work on hard material. For various reasons, the speeds and feeds of American machine tools are higher than on European; from 10 to 20 per cent., I should say, and in special cases even more. Lathes and turret machines have a coarser feed per revolution; milling machines have faster surface speeds and coarser feeds; planers have a quicker working stroke. In methods and devices for easy handling and quick manipulation the American machine is in advance of the European. In weight and distribution of metal, the American machine is well suited to American conditions, but not always European. The phenomenal rates of feed, about which we have recently heard so much, have not been maintained in practice, although the results of these experiments have been beneficial in strengthening and otherwise improving the design of the milling machine. The wonderful results which were promised from the milling machine when running the feed with the cutter have not been realized. I have seen in an American machine shop milling cutters operating on a steel shaft with a feed of 18 inches per minute, cutting a keyway $\frac{1}{2}$ an inch deep and $\frac{3}{8}$ of an inch wide, but when questioned, the foreman stated that this was hardly an every-day rate of feed.

As to the style and appearance of machine tools, to the American eye the European article looks clumsy and heavy; to the European eye, the American machine looks light and flimsy. It is largely a matter of taste and custom, of course, but certainly American designers pay more attention to artistic effect and graceful lines than the European. It is of undoubted commercial advantage to do so. It is a "selling point," the attainment of which adds nothing to the cost of the machine and assists to secure orders. In heavy machinery American and European style and form more nearly approach each other. Although the clumsy machine may be capable of producing just as much and as accurate work as the more graceful in form, still the latter, other things being equal, is evidence of more

careful design which in the end means greater usefulness. In machine-tool design utility is the first principle of beauty, but beauty need not be thrown to one side as a useless factor. While the American machine tools were mainly and originally copies of the English, characteristics of American design are now copied by many European makers, much to the indignation of some virtuous American makers who are continually pirating each others' patterns.

The usual American machine tool is superior to the usual European machine in the matter of accuracy and quality of workmanship. There are makers of low grade machinery in America and there are makers of high grade machinery in Europe, but there is however comparatively little really low grade machinery now sold in America, while there is an enormous amount of cheap machinery made in Europe. The recent statement made before the German Engineers' Club that the quality of American machinery is deteriorating is entirely misleading and untrue. For years the European trade in American machine tools has been practically confined to the best makers, those with a reputation like Brown & Sharpe, and Pratt & Whitney. The market for, and reputation of, American machinery abroad has been made by firms with a standing like the above. Inferior makers have followed in their wake and have sold quantities of machinery which had every appearance of the better quality article, in style and polish, but were of low grade workmanship and design, and sold for a much lower price. Great quantities of this second quality American machinery are now being sold in Europe; in view of this fact the report finds a ready belief amongst German engineers that American machinery is not of such good quality as formerly. The opposite is the truth. The quality of American machinery made by the best makers is improving both in design and workmanship, with an exception in one particular, perhaps. Some American makers, in their endeavor to reduce cost of manufacturing, are using material which, while answering perhaps every requirement of American practice, is of such a nature that it does not meet European conditions. American makers do not seem to realize that their machines must operate upon rougher and harder material than is commonly used in the States. I know of one recent case where feed screws in several milling machines of one of the best American makers had to be replaced because they would not stand the strain when working on the hard material which is commonly used in Europe.

In respect to prices, the American machine tool of highest quality is lower than the European of highest quality. In good grades of

machinery, not the highest, the American is also cheaper. This is due to specializing largely, and to other causes dealt with in a previous article. In really cheap grades of machinery I think the European takes the palm for the amount of cast iron he can supply, worked, to all intents and purposes, into the shape of a machine tool. It is surprising what an immense amount of machinery is still sold in Europe in competition with better grades solely on the strength of a greater amount of metal offered for the same or even a less price. It is likely that this trade is heavily encouraged by exporting houses whose enquiries alone are sufficient evidence to prove that they have no standard of value but weight.

The capital of the mechanical worker may be said to consist of his strength and skill, and the hand-tools which he possesses. In the development of these tools or aids to the manufacture and maintenance of machinery, America is far ahead of Europe. The American workman is individually much better equipped than the European with accurate, easily manipulated, labor-saving hand-tools. Accurate hand-tools are made by a number of European producers, but as a rule they are clumsy and lacking in the details which tend to make them quick acting and adaptable to a great variety of uses. Fine measuring instruments are extensively used and thoroughly appreciated by American workmen. They are not commonly understood and are comparatively little used by the European. Generally speaking, neither workmen nor employers recognize them as an important factor in the production of good machinery. A skilful workman may do a fine job unaided by fine tools, but he cannot do it as cheaply nor as quickly; without them interchangeability is practically out of the question. European employers should recognize the value of labor-saving hand-tools which are of as much importance as other auxiliaries, especially in the production of parts like jigs, fixtures and small tools. Some large American concerns furnish to all employees what they consider the necessary hand-tools and instruments, charging nothing for them except in case of misuse or loss. Aside from this, I think it is safe to say that a majority of the best American mechanics possess from 50 to 100 dollars' worth of the best quality of hand tools and measuring instruments, some even to the value of 200 dollars. I have repeatedly noticed the kit of the European mechanic to consist of nothing more than a slide caliper, costing perhaps 4 or 5 shillings, a sheet metal square, a hammer, a chisel or two, a centre punch and a little tin box of powdered emery. Verniers, micrometers, sets of accurate squares, a variety of scales, quickly adjustable dividers and spring

calipers of different sizes, surface gauges, a number of hammers, straight edges, centre gauge, and sets of wrenches is the common equipment of the better class American mechanical worker. It is interesting to note that enormous quantities of American tools of the above class are now being sold in Europe. Where they are tried and are in use they are preferred by the European to any others.

By the aid of improved machinery, that which at the beginning of the century was the luxury of the rich is now the comfort of the poor. Material and labor are no longer the sole factors of production. Assisted by machinery and tools, man's labor now converts the raw materials of nature into the useful, necessary and, in some cases, even the artistic paraphernalia of civilization with one third of the exertion formerly necessary. Even Russia, the latest competitor in the industrial field, has, with the aid of machinery, more than doubled, since 1861, the individual output of those employed in her manufactories. In the course of 20 years (1870-90) the number of persons employed in the American manufactures has more than doubled, and the value of their product has nearly trebled.* I mention these facts to show the important part that machinery now plays in modern industrial warfare. Few realize or stop to think how much we are indebted to the inventor and machine designer for the comforts, luxuries and necessities of our daily life. The loom which weaves our silks, cottons and woollens; the harvesting machines which reap our corn; the machinery which forms our bricks and mixes our mortar; the printing machine which makes the penny daily possible. Our food, clothing, furniture, literature, all are produced on machinery which it is practically impossible to make or maintain without the modern machine tool. European manufacturers themselves do not realize the important part that the machine tool plays in American industry, particularly in the maintenance of plant. As before stated, there nearly every industrial establishment of importance supports an auxiliary equipment of the best machines and small tools, and employs high wage earning mechanics for the purpose of keeping its plant in a high state of efficiency. Without this backing America could not have attained the place she now occupies in the commercial race against all European nations. It is the direct result of the high development in the art of machine-tool making that America can now send to Europe nearly every article of commerce required by civilized nations, pay freight and duties, and still compete with the home product. There are but few exceptions to this broad statement,—perhaps in textile fabrics and steamships.

* P. Kropotkin; *Fields, Factories and Workshops*.

Still I have lately seen suits of clothes made to order for a full grown man advertised at \$4.95, and a number of orders for steamships have recently been placed in the States by foreign governments. A well known American maker of steam engines is regularly sending his product to different European countries, competing with local makers, and paying on an average 30 per cent, for freight and duty. Agricultural machinery has been sent to Europe for years by American makers; this machinery requires the most advanced machinery for its production; the castings for it are produced in some cases for less than one cent per pound, the steel and iron used costing but little more than cast iron. A very large business is done by American makers of pumping machinery in Europe. The recent excessive demand for railway supplies in Great Britain has driven orders to America, and locomotives are now being made there for English railway companies. It is well known that very big orders have been given to American concerns for the equipment of the new electric railways in London,—cars, engines, and electric apparatus, chiefly I believe on account of quick deliveries which could not be undertaken by European makers. I know of a number of orders recently placed in the States for large travelling cranes that can be delivered, including freight and duty, for the same price that the European maker can quote, with far quicker delivery and of workmanship that is superior. The completely erected steel structural work for a very large building has been recently supplied by an American firm to a European company for 15 per cent. less in price than that offered by European competitors. An American company is doing a good business in London supplying steam radiators. Although the boom is over, the American cycle is now a fixture in the European market, where formerly the case was reversed and America was a large buyer of the English article. Typewriters, which require, perhaps as much as any manufactured article, machinery of precision and high mechanical skill are almost exclusively made for the world in America. I know of but two factories in Europe producing writing machines, and these only make a comparatively small quantity. The United States exported in the year 1898 typewriters to the value of nearly two million dollars. American brass goods are finding their way into the European market, and users state that they are interchangeable in parts, which is not true of the usual European make. Bolts and nuts are now supplied to England from America, in some cases for 25 per cent. less in price than the domestic product.

America already has a good trade established with European

countries in steel and iron, particularly for those grades where accuracy is desirable.

Many European manufacturers are now sending to America for pig iron, rolled and drawn steel and brass, malleable castings, and, in some cases, for ordinary castings, for the simple reason that, in many cases when using European materials, it is out of the question to secure the product from highly developed accurate working machines which they are capable of turning out. This importation of American material is sure to be more extensively practiced as soon as it is more generally known for what a low price it can be delivered in European countries, freight and duty notwithstanding. In price American material easily competes with the European; in quality it is, in many instances, superior.

I recently saw the steel stores of a good sized cycle factory in Germany completely stocked with American material. The manager informed me that he orders all material from America after having made every attempt possible to buy accurate (guaranteed to run within a limit of 2 thousandths of an inch), easy working material in Germany. He had given German material thorough trials but could not get the right thing. The American material, with freight and duty added, costs him less than the European article. It seems to be a plain case of the European steel makers' failure to understand the value of accurate machinery and tools, and their maintenance.

In addition to the above items is, of course, the steadily increasing business which American machinery makers are doing with Europe. America exported metal working machinery to the value of \$5,500,000 in 1898, mostly to European countries.

The inevitable conclusion is that America leads the world industrially. I have tried to show the important place the highly developed machine tool occupies in her industrial establishments. It is indispensable to accurate, cheap manufacture. It is the one factor possessed by Americans which Europeans can at once make use of; buy or copy and immediately apply to rejuvenate their out-of-date equipments. They are doing this, and have made a good start in adopting American machinery and practice in many of their industries. It is surprising, though, how many European manufacturers are jogging along with a mediæval trot, ignorantly, almost blissfully, unconscious of the progress that others are making. With respect to other conditions, however, which are advantageous to America in the industrial race, it is not so easy for Europe to cope. In commercial management she can, and does in many respects, although political institutions and

social customs do not permit such rapid changes (which are not always for the best although in the long run more progress comes out of them) as in America. New commercial methods must naturally follow mechanical and scientific improvements. Again, economic and social conditions in Europe are almost irretrievably opposed to the development of labor to as high a degree of efficiency as is common in the States. Equally favorable results can, for the present, be realized in Europe only in isolated cases where employers and managers thoroughly understand the case and are strong enough to organize and retain a *personnel* which can resist outside influence and environments. In such establishments the wage rate, per unit of time, must be high (for Europe), but per unit of product will be low. In the item of raw material European manufacturers can not hope to compete with the States. America is far richer in natural resources than Europe, and is better organized for the handling and distribution of raw products.

But what of the future? With an abundance of raw material, effective division of labor, the most advanced machinery and shrewd commercial management, is America possessed of all the elements by which she can retain her industrial supremacy? I think not. She has difficult problems before her which are already pressing for solution and must soon receive recognition. Undoubtedly the division of labor, in which America is so far advanced, is, if properly organized, the most economical method of production, but if carried to an excess, as it is fast becoming the case in America (it is moving in the same direction in Europe, although more slowly), there will be a terrible reaction on the part of those workers who perform the routine operations in the modern manufacturing plant. The free social life, out of which progress has come in America and which is still the vital element of its industrial development, is slowly forging the instruments of its own destruction. The factory and machine shop hand is becoming the slave of the automatic machine and the model shop. No diversity in his labor, no development in his mind, no progress from his experience. This is the danger to American workers. To avert it, they must soon seek methods of diversifying the life of the routine laborer, giving him a better education and teaching him to think, to study, to improve and to find time for recreation. If this is not done we cannot look for the rapid improvement in the future that we have seen in the past, for it is from the mass of workers that most of the American inventions and improvements in machinery have come.

In America petty industries practically do not exist. It is the land of large factories, big combinations and high pressure specialization. Progress is unhampered by labor combinations. In Europe conditions are different. Petty industries still survive. Organized labor fights specialization, employers' combinations, and labor-saving machinery. The same economic tendencies may be observed but they are not so far developed. Both continents are striving for the ascendancy in home and foreign markets, but in neither do we but rarely find a manufacturer who realizes that social economic problems exist. How keenly all are bent on studying the machine, its design, its output, care and development. How few take any thought for the care and development of the human machine, that most important of all factors in reducing the cost and improving the quality of product. How many employers think of the condition of their work people as often as they do of their truck horses, of their stokers as well as of their boilers? What manufacturer cares as much for the food of the milling hand as he does for the quality of the lubricant of the machine which the milling hand attends, or gives as much anxious thought for the longevity of the turner as for the lathe which the turner runs? Who would expect profitable returns from a machine quartered in the damp and stifling atmosphere in which thousands of our factory hands live? Both Europeans and Americans are straining every nerve to increase the productivity of their machinery, but there is no competitive strife amongst manufacturers which aims at creating a class of well fed, well clothed, sheltered and educated, and consequently strong and intelligent, operatives. Yet without such, good machinery and useful inventions are impossibilities. It is from the ranks, those who come in daily and hourly contact with the realities of production, that improvements come. The human being which forms the most important part of a manufacturing establishment, receives too little consideration from the employer. Neither in Europe nor in America have the social and economic questions received the same attention that the mechanical and scientific have. They cannot be put off much longer, however. I believe the nation will advance most rapidly which grapples with these questions first, and combines the study of the welfare of its workers with that of improvements in its mechanical equipment. To which hemisphere will the reward and the honor be given?

HYDRAULIC TRANSMISSION AND DISTRIBUTION OF POWER.

By E. B. Ellington.

HAVING analyzed the cost of generation and transmission I will now proceed to the question as to what can be done with hydraulic power when obtained. In order to get a clear idea of the economical limitations of its use, it is necessary briefly to refer to the properties of falling water flowing under

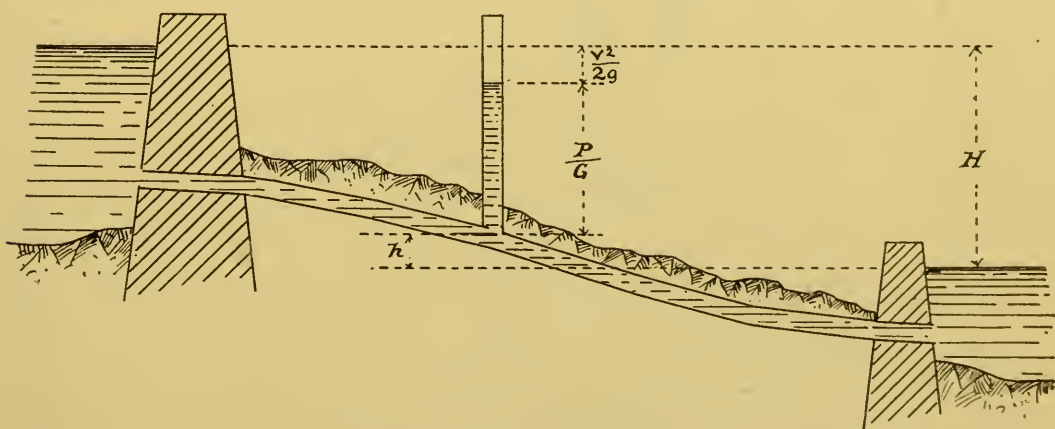


FIG. 1. PROPERTIES OF FALLING WATER.

pressure. This is very tersely stated by Professor Unwin, as follows :

Suppose the water to descend at a uniform rate through a pipe (Fig. 1), which we may imagine frictionless. At any point h feet above the lower level, the water will in general have acquired a pressure p and a velocity v . And in that case we know that

$$H = h + \frac{P}{G} + \frac{v^2}{2g},$$

where h is the unexpended part of the fall, $\frac{P}{G}$ is the energy corresponding to the pressure and $\frac{v^2}{2g}$ the energy corresponding to the velocity of each pound of water. Consequently the head may take three different forms, and, at whatever point of the pipe we make the examination, these three positions of head add up to the same total amount.

The three methods of utilizing the power at disposal require corresponding machines. The first, or the mere weight of the water, seldom is in evidence in hydraulic machines working under high pressure. It is principally used in overshot wheels, which may be

considered out of date since the advent of the turbine, but there is one application of the direct weight of water in a hydraulic machine which I will explain, as it involves a rather neat hydraulic problem.

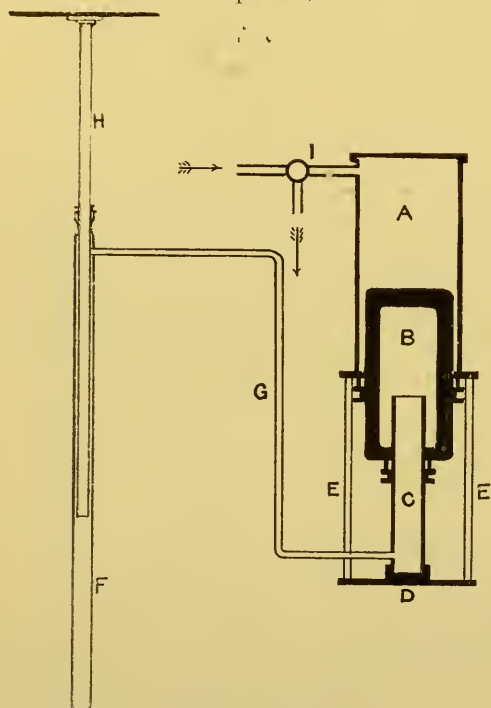


FIG. 2. HYDRAULIC COMPRESSION CONVERTER.

It is a case of conversion of low-pressure into high-pressure water. A is a low-pressure cylinder. B is a weighted moving ram working in A. C is a fixed hollow ram with base D secured to cylinder A by the tie-bolts E E. F is a lift-cylinder communicating with C by the pipe G. H is the lift-ram working in F, and of the same capacity as C.

Now, it will be understood that when the lift is down the ram H at the bottom of the cylinder F is immersed in water, and has displaced water previously in the cylinder and equal to its immersed bulk. The displaced water, passing through G into C, raises the

ram B to a height corresponding to the ratio of the respective strokes of the rams. When H is at the top of its stroke it weighs more than it did at the bottom by the weight of the amount of water previously displaced. But while H is coming out of the cylinder and increasing in weight, B is also coming out of cylinder A (B, C, G, and F forming a closed system), and is also increasing in weight by the amount of water flowing into A from the supply-pipe I. By properly proportioning the diameter of the rams H and B, the apparatus is in perfect balance in every position, notwithstanding the disturbance due to the variation in the load. I should mention that in ram-lifts it is often important, especially with low-pressure supplies, that this variation in load should be balanced, as it may be considerably more than the maximum net load in the cage. That it is really the dead weight of the water in the cylinder A which does the trick, is proved by the fact that if the apparatus is laid on its side, though the machine will work it will not be in balance. It is a curious illustration of the effect produced on a hydraulic machine by a mere change of position without alteration of any of the working parts.

In nearly all the hydraulic machines it is either the pressure directly or the velocity due to the pressure which is utilized. Unfortunately, however, the weight of water can never be disregarded, and it is the weight which determines the most important limitation in the economical use of hydraulic power. It is impossible to employ high velocities of flow in the mains and machines except for inappreciable distances. The loss by friction in transmission increases as the square of the velocity, and for these reasons a greater velocity in the mains than six feet per second can not be permitted. The average velocity of flow through the mains in London is not more than four feet per second. In the pressure-machines themselves a higher velocity is allowable, but eight feet per second is rarely, if ever, exceeded. It is clear, therefore, that where the pressure is directly utilized it can only be with a comparatively slow-moving ram. It is precisely in this class of machine where hydraulic power gained its laurels, and in which its position remains unshaken to-day. It is clear that the higher the pressure the smaller the machine and the less the weight of water used to do a given amount of work. The less the weight of water the greater the velocity that may be allowed in the machine, and the greater the power that can be supplied through a given-sized main.

The limit of pressure as regards the mains is their cost, which increases in a higher ratio than the pressure, but the practical limit of the pressure of a general supply is the convenience of the consumer. It is doubtful whether there is any advantage in fixing pressures for public supplies much above 1,000 pounds per square inch. The supply given in Manchester and Glasgow, at about 1,100 pounds pressure, has been very successful, especially in the former city, where so much bale-pressing is done, but in London 750 pounds has proved a quite satisfactory pressure; yet if I were laying out the supply in London at the present time, I should provide for a maximum of 1,000 pounds.

Hydraulic pressure is, then, peculiarly adapted to cases in which a great effort has to be exerted through small space, and in which comparatively few reversals of motion of the pressure-ram take place. Water being practically incompressible, it follows that when the pressure is constant the same power is exerted throughout the stroke, and a further limitation of superiority over other kinds of power has to be made, namely, that the demand for power should be intermittent, *i. e.*, the power should be exerted during short periods of time. These conditions are fulfilled in nearly all lifting

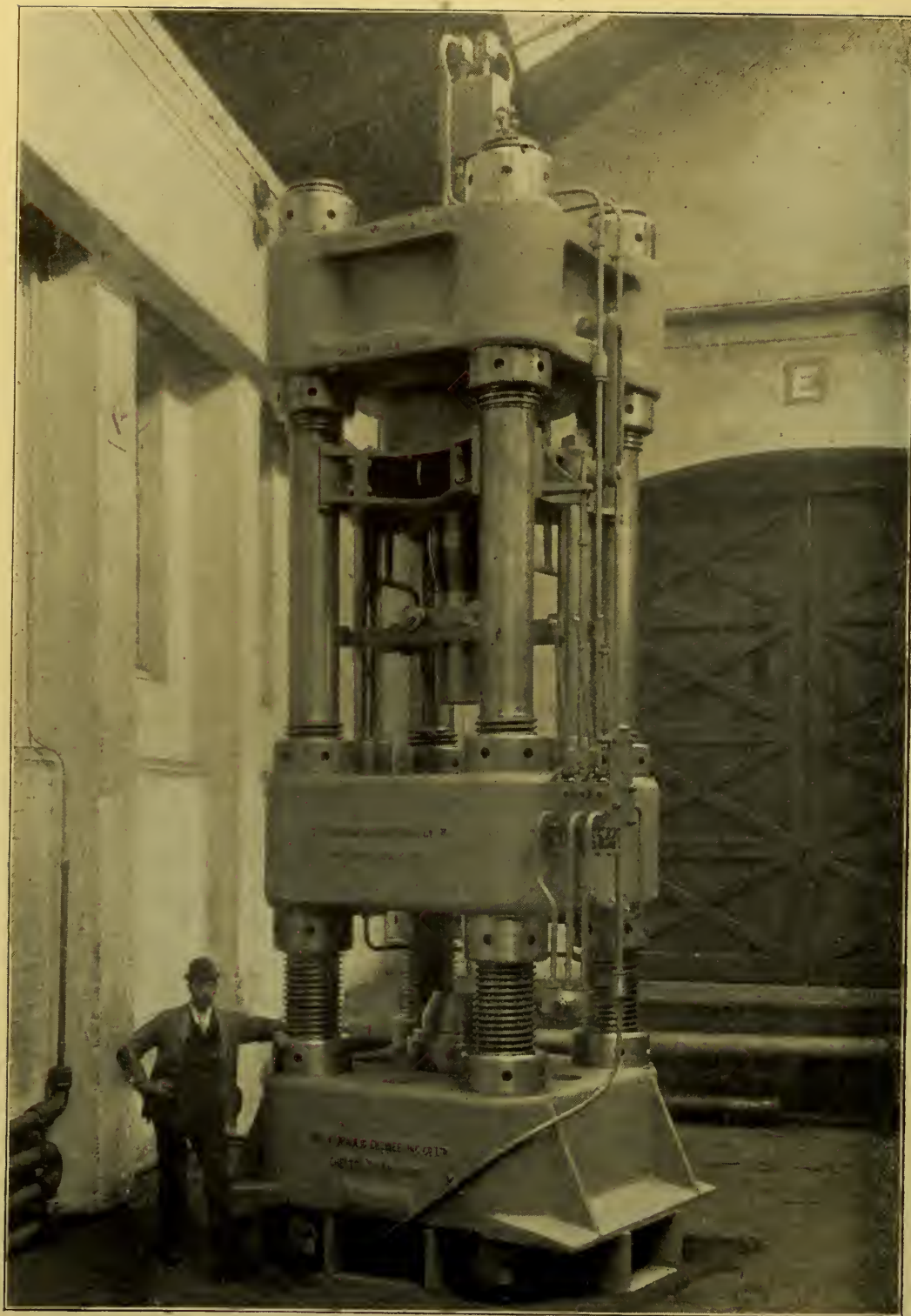


FIG. 3. 2,500-TON CARTRIDGE HEADING AND INDENTING PRESS, WOOLWICH ARSENAL,

and pressing operations, and to a limited extent in haulage. The incompressibility of water gives the further important advantage in lifting-machines that no brake is required. When the valve controlling the motion is closed, the water in the hydraulic cylinder is the brake. As a matter of fact, the pressure in the working-cylinder is never constant, but varies with the resistance, and when the loads are below the maximum the speed of working is increased; and as an increase of speed very rapidly absorbs the surplus power by fluid friction, hydraulic machines cannot race the water itself without any special mechanism acting as an automatic brake.

One of the most important uses of hydraulic power is for forging-presses. The hydraulic press in all large forging work has in recent years superseded the steam-hammer, in well-equipped establishments, and they are the largest hydraulic machines constructed. Four thousand ton presses are common and there are several of 10,000 tons. They are worked with pressures up to three tons per square inch.

It may, I think, be stated with confidence that the modern system of heavy forging depends for its success on the peculiar advantages of hydraulic power for pressing operations.

For pressing I imagine nearly every engineer would admit that hydraulic power is supreme. If hydraulic power is the best system for presses, the conclusion can hardly be avoided that it is also best for lifting. Strictly speaking, a hydraulic press is the essential feature of every hydraulic lift or crane. It is true that there are cases of lifting-machines worked by hydraulic engines. Such machinery can be nearly equally well worked by a steam-engine, a gas-engine, a dynamo, or a compressed-air engine. A real hydraulic lift or crane is, however, one in which hydraulic presses constitute the lifting appliance. In many cases, as in any simple ram-lift, there is in fact no clear mechanical distinction between a hydraulic lift and a hydraulic press.

What I wish to point out is that there is really no such thing as a steam-crane or a steam-lift or an electric-lift in the same sense as there is an hydraulic lift or crane. It is often advantageous to work a lift or crane by steam or electricity or by gas, but, broadly speaking, it is not, and apparently can not be, so worked directly.

Hydraulic power stands quite alone and apart from all the other systems of power-distribution in virtue of its pressure being applied directly to the lifting appliance without the intervention of any so-called engine. All other kinds of power require ordinary gearing. Other systems of lifting-machines are thus, mechanically consid-

ered, fundamentally and necessarily inferior. Of course, in engineering as in everything, it is often impracticable to use the best method, and it not infrequently happens that what is best from one point of view is not so from another; but I am on sure ground when urging that there is always a *prima-facie* case for using hydraulic power for lifting operations when such power can be had. Hydraulic lifting-machines are safer, owing to the direct action of the pressure, the absence of brakes, the simplicity of construction, and the certainty of their control.

With full loads hydraulic lifting-machines possess great econ-

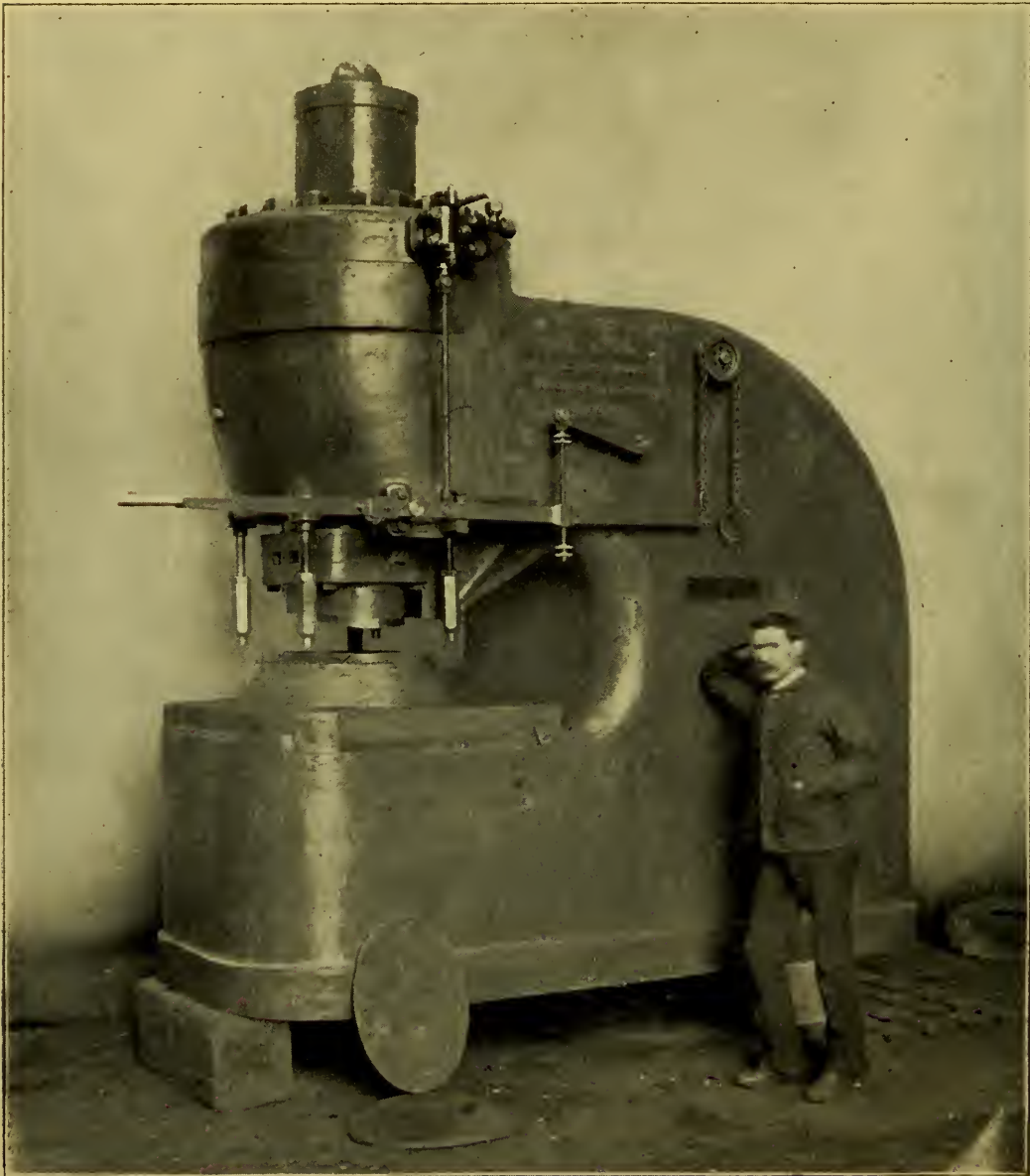


FIG. 4. MANHOLE SHEARING MACHINE.

For 23 x 16 inch manholes in $\frac{3}{4}$ inch steel plates.



FIG. 5. HYDRAULIC WAGON HOIST FOR MIDLAND RAILWAY.

omy, especially where direct action can be used, as in an ordinary direct ram, coal, or wagon lift. The efficiency may be as high as 95 per cent., and even in suspended lifts, when the stroke of the ram is often multiplied eight or ten times, the efficiency may be 75 per cent. At light loads the economy is less, but it is usual where the loads

vary much to make the machines of double or treble power, and in this way machines are kept working near their respective maximum efficiencies.

As to relative economy, it appears that a good electric lift takes more power to run with a very light load, or no useful load at all, than the corresponding hydraulic machine at full load.*

On every ground the superiority of the hydraulic system for the more ordinary kinds of lifting operations is maintained.

Before leaving the subject of hydraulic-pressure machines, I should like briefly to mention the use of hydraulic power for pump-



FIG. 6. PLAN OF HYDRAULIC MAINS AND SUMPS, BUENOS AIRES DRAINAGE SYSTEM.

ing. I refer more particularly to sewage-pumping. Water-pressure mine-pumps working in lower levels have been in common use for a great number of years. Pumping, especially against a constant head, seems to be one of those operations for which hydraulic pressure is admirably adapted. A complete hydraulic pump may have only one moving ram. The action can be made automatic, so that a large number of hydraulic sewage-pumps located at various places in a town can be worked from the central station, the pumps automatically adjusting themselves to the varying flows of the sewage at different parts of the

* See Ravenshaw on "Electric Lifts," and discussion, Minutes Inst. C. E., Vol. CXXX.

town. The power-water used helps to flush the drains. A slight variation in the size of the power-rams enables a standard pattern to be used at all the substations, even when the elevation is very variable. The efficiency of the pumps is high, and the plant simple and durable. This system has been adopted on a large scale with great success at Buenos Ayres and at other places.

Now, it is difficult to see how electricity could be used for this purpose with anything like the mechanical directness and simplicity of the hydraulic machines. Pumps you must have in any case. These pumps must be geared to reduce the high-speed dynamo to the necessarily low-speed pumps. Where hydraulic power is not available and electricity is, the question would assume a different aspect, but the electric can not be the best system as a matter of mechanics.

For this work of sewage-pumping many engineers may prefer compressed air, and the apparatus required by compressed air as



FIG. 7. STANDARD 1-TON TURNOVER CAPSTAN, IN POSITION AND TURNED OVER.

carried out under the Shone system is even simpler and more direct than the hydraulic, as the pumps may be said to have no moving parts. As compared with hydraulic power, however, the efficiency is very low. The two great desiderata in all mechanical contrivances are simplicity of construction and efficiency (*i. e.*, economy) in work. These two essential elements are often woefully antagonistic, but both are special characteristics of typical hydraulic machines.

For reasons stated, hydraulic pressure is not very suitable for rotary engines for ordinary purposes, such as driving the machinery in a work-shop, and in most cases where the power is used for general work it is better to utilize the velocity of the water by means of turbines instead of pressure. There are, however, a few applications in which the superiority of hydraulic-pressure engines has been thoroughly established. The most important of these is for the

working of capstans in railway-goods yards and in docks. In this case the work is intermittent, great power has to be exerted for a short time, and the control is perfect. The hydraulic engine goes into a very small compass, and can be attached directly to the capstan-head. Hydraulic-pressure machines also seem to be preferred to any other system for working the bellows of organs. A considerable number of such machines are connected to the hydraulic-power mains in London, and in this case also one of the most important elements of success seems to be the perfection of control obtained. I have already referred to the gigantic forging-presses now so extensively used in steel-works, but there are a number of other workshop-tools in which hydraulic pressure has eclipsed all other systems. This is particularly the case in riveting-machines and boiler-shop tools generally, in which hydraulic pressure can be made to take the place of geared machines. Hydraulic-pressure machines have also been largely used on board men-of-war and in the merchant marine for gun-work, turret-turning, steering-gear, cranes, and capstans. In many of these operations certainty of control is what is most wanted, and it must be admitted that hydraulic machinery stands at the top of the systems in this respect. It seems to me, however, that there is much to be said in favor of electrical transmission on board ship, and that its advantages are so great that it may become the paramount power for doing the odds and ends of the work of a ship, now performed by steam or hydraulic power.

The facility with which electricity can be conveyed from point to point, the small space in which the central engines and dynamos can be placed, the comparatively small weight of material required to develop and utilize the power wanted, and the fact that electricity must be obtained for lighting in any case, all point to the desirability of its use on shipboard where practicable. The question is whether these advantages are sufficient to warrant its adoption for lifting and similar operations when doing so would undoubtedly entail a less effective control, diminished safety to the men engaged on the work, and a greater risk of fire. It is to be remembered that hydraulic power has displaced steam in the best-appointed ships, and for similar reasons it may continue to be preferred to electricity. A good deal more experience is required before any definite conclusion can be drawn.

I now come to the third method of utilizing the energy of water flowing in a pipe under pressure. The velocity of the flow from an open-ended pipe is $8\sqrt{h}$ multiplied by a coefficient which varies

with the nature of the orifice. The head (h) must be, of course, the effective head at the orifice; that is, the real head less the loss due to friction in the pipe. There are ways of utilizing the energy of the velocity of flow of water in a river or an open channel, such as the old undershot wheel, but in connection with the subject of the distribution of hydraulic power it is not necessary to deal with any applications of the principle except where the energy is conveyed through mains.

The only way in which the velocity of flow in mains can be utilized with a high efficiency is by means of a turbine.

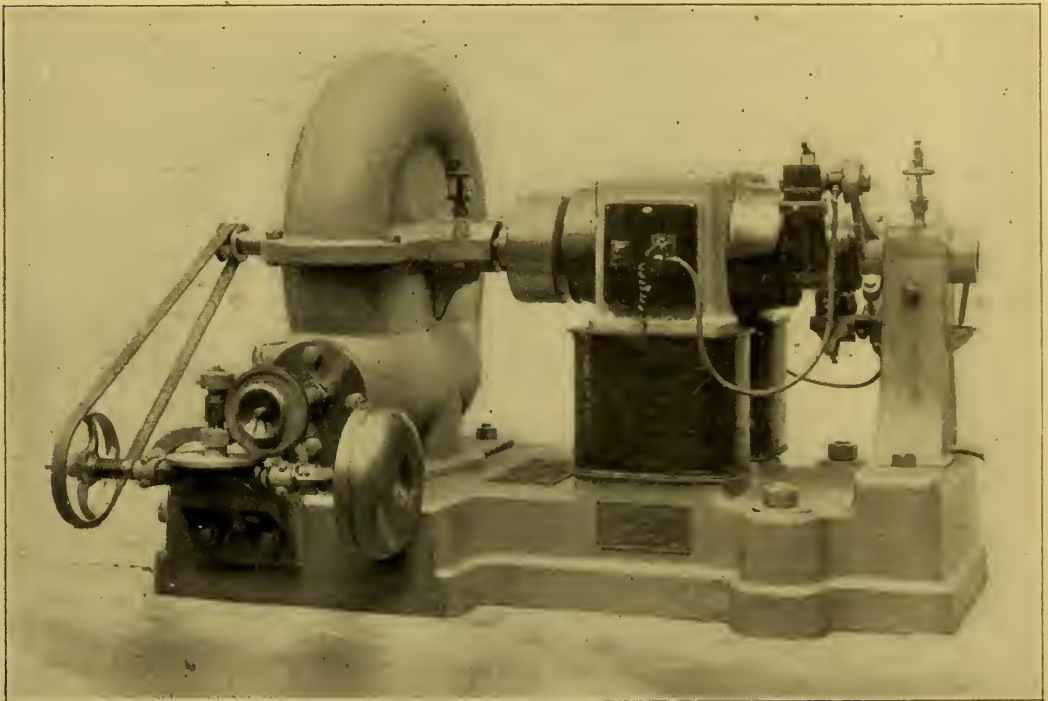


FIG. 8. 18-INCH PELTON MOTOR DRIVING DYNAMO FOR 50 16 C. P. INCANDESCENT LAMPS.

The subject of turbines is very interesting, and there is considerable literature on the subject. When well designed and constructed, turbines give the high efficiency of about 80 per cent., irrespective of the particular type. When using high-pressure water, however, the impulse or Girard turbine is the only form which will give anything like this efficiency. The velocity of flow due to a pressure of only 750 pounds per square inch is 320 feet per second, and there is much difficulty in dealing with so high a velocity. The well-known Pelton wheel, which may be considered a sort of double Girard turbine, has been almost the only one used for pressures of 700 pounds per square inch and upward. In the Pelton wheel a

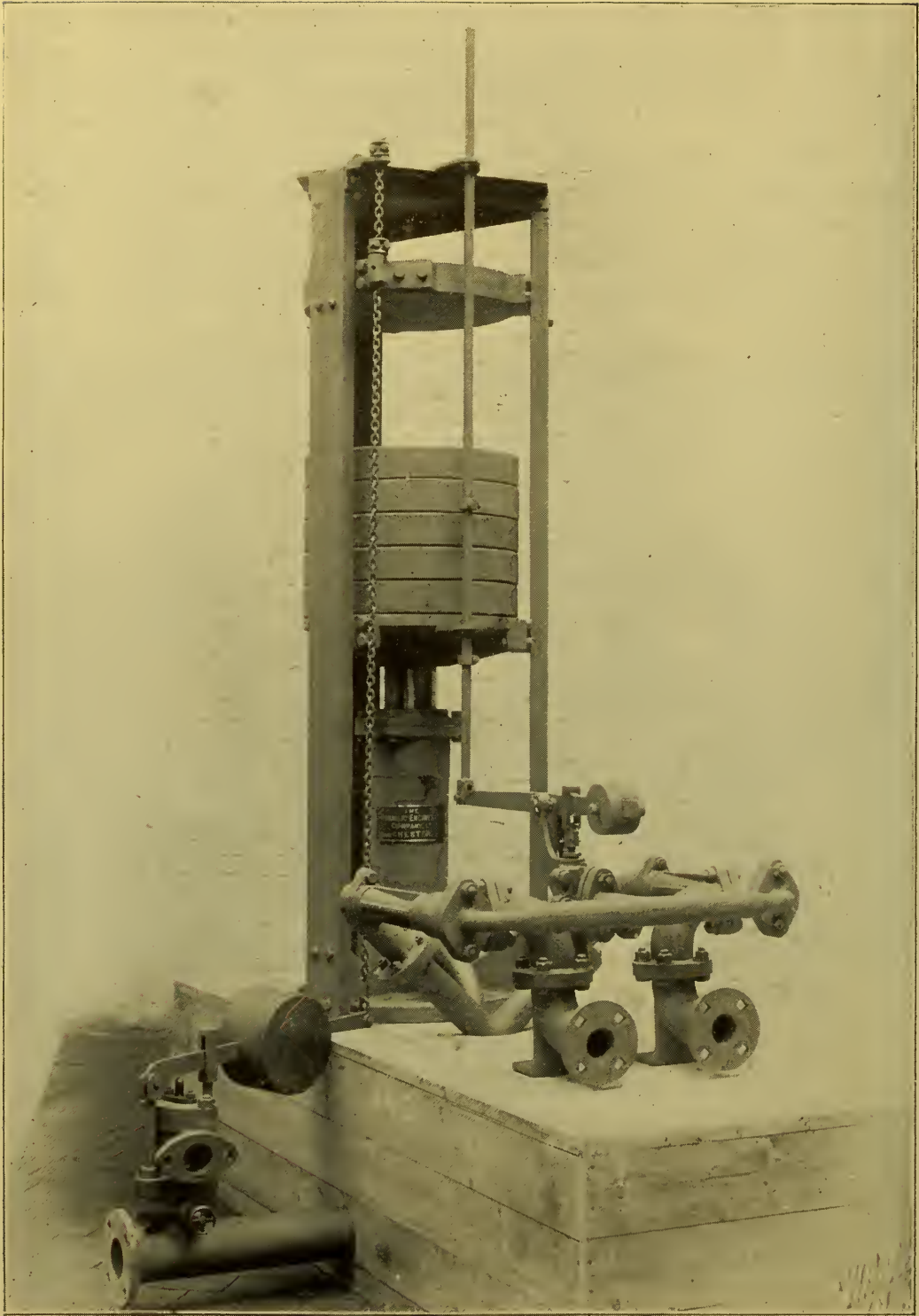


FIG. 9. AUTOMATIC WATER-SUPPLY APPARATUS FOR FIRE PROTECTION.

jet of water from a nozzle is allowed to impinge upon a number of cups on the periphery of the wheel.

The circumferential velocity of the wheel must be half the velocity of the jet. In the case of 750 pounds pressure-water, this would be 160 feet per second. For small powers the wheel cannot be made of large diameter, and the revolutions must be from 1,500 to 2,000 per minute, while the size of nozzle to give one horse-power is only .072 of a square inch. It is thus impracticable to make high-pressure turbines for very small installations, and they can not be economically used for less than one-half horse-power at this pressure. In order to obtain the maximum efficiency, turbines must be run at or near their critical speed, and it is not at all an easy matter to govern them effectively when the jets are so small. It is required to enlarge or contract the jet with the variations in the load. In Fig. 8 is shown the governing apparatus as made by the Hydraulic Engineering Company. It works quite well if the variations in load are not very sudden, but will not control all variations. The combination of a Pelton wheel and dynamo is a very pretty one. The wheel and armature are mounted on the same spindle, and the dynamo is constructed to run at the critical speed of the wheel.

The combined efficiency of the apparatus is about 66 per cent. with an eighteen-inch wheel exerting ten horse-power. By this means, on a large scale, hydraulic power can be converted into electric current with a loss of 33 per cent. in the process. The electric motor can be used to work a high-pressure pump, and thus convert electricity into hydraulic power with a loss of 20 to 25 per cent., because a pump has a higher efficiency than a turbine. This is fortunate, as there are more cases in which it is desirable to use electrical power for pumping than hydraulic power for developing electricity. This has, of course, nothing to do with natural water-power. In such cases, with low pressures and large powers there is no difficulty in effecting the conversion of hydraulic to electric with an efficiency of 75 per cent.

The great facility with which electric power can be subdivided renders it better adapted than hydraulic power to the thousand and one small purposes for which power is required in towns and workshops. The cases in which it can be advantageous to use high-pressure hydraulic engines and turbines are comparatively limited when either gas or electric power is available, but the relative position of hydraulic power in this respect is not due to any inferiority in the economy of the production and distribution of the

power, but solely to the mechanical difficulties in the way of utilizing it to the fullest advantage for such purposes.

There is one other application of the energy of the velocity of high-pressure water flowing in a pipe which is of great utility and importance. This is the injector fire-hydrant, to which I have already incidentally referred. Hydraulic power has not been

used for the extinction of fire to anything like the extent which might have been expected, or that was contemplated by the late Mr. Greathead when he introduced the injector hydrant. Nevertheless it has been slowly making its way in private installations where hydraulic power is available, and it is undoubtedly capable of rendering the greatest possible service in places like London, where the pressure in the ordinary water-mains is too low to make the common hydrants really effective. In the injector hydrants a small jet of high-pressure water playing into the center of the injector, which is also attached to the low-pressure mains, increases the flow in the latter and intensifies the pressure in the hose-pipe. The injector hydrant will also suck water from a tank in the same way as an ordinary pump. It is to be noted that the pressure in the hose can be anything that the hose is made to stand, nearly up to the limit of the high-pressure supply. If that supply is, say, 750 pounds per square

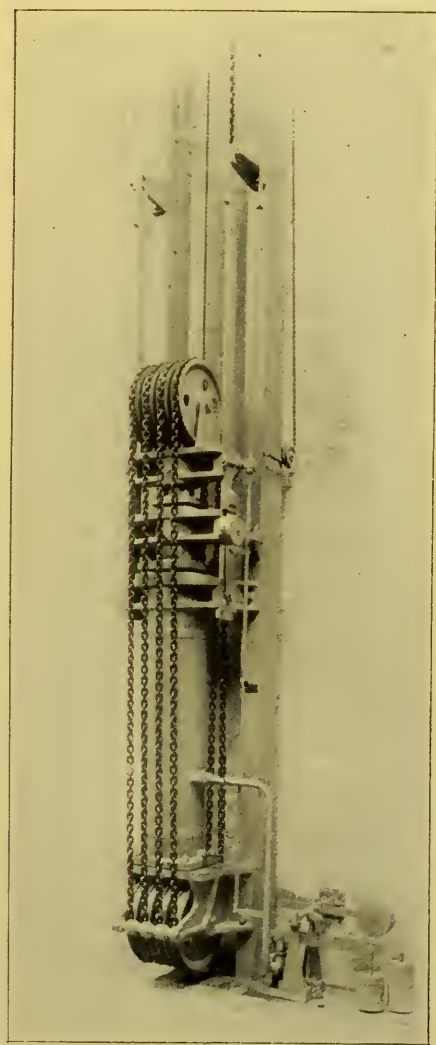


FIG. 10. DOUBLE POWER JIGGER.

inch, it is obvious that nearly as powerful a jet can be obtained at the top of the highest building as at the street level, or the jet can be applied many hundred yards away from the hydrant, substantially with equal effect as if it were near. For this reason fewer injector hydrants are required in the streets of a given area than when ordinary hydrants only are used. The apparatus shown in Fig. 9 is a device for rendering these injector hydrants automatic

on the outbreak of fire. It is primarily intended to work in connection with sprinkler systems in place of an automatic steam-pump, but it can also be used in connection with ordinary hose connections to maintain a given pressure in the fire-service, irrespective of the pressure in the ordinary water-supply mains in the street. The apparatus consists of one or more injectors connected with a controlling accumulator, which at once falls and starts the injector when any sprinkler or fire-hose nozzle begins to play. A slight leakage is provided for, so as to allow the accumulator to descend very slowly. It is then automatically raised, and the apparatus is thus always kept in working order.

The subject of hydraulic as of every other method of power distribution is a very large one, and it is quite impossible within the limits of an article to do justice to it; but I have, I think, said enough to show that for many purposes hydraulic power is mechanically the best form of energy and the most economical. That the views I have expressed here have not been unduly coloured is evidenced by the fact that in every town in which a public supply of hydraulic power has been established it has succeeded both mechanically and financially, notwithstanding the competition of all the other forms of energy. The experience in Manchester is particularly striking. The supply of electricity, of hydraulic power, and of gas are all in the hands of the corporation. The two former were started at the same time in 1894. The pumping-station was of considerable capacity, 1,200 horse-power. The electrical current is supplied for power-purposes at very low rates; nevertheless the demand for hydraulic power has so increased that a second station is being put down of equal capacity to the first. In London the demand for hydraulic power has increased more rapidly since electricity has been available for power-purposes than previously.

During the period from 1890 to 1893 the supply in London rose from 177,000,000 to 275,000,000 gallons in the year, while in 1897 it reached 524,000,000 gallons, and recently the supply has been at the rate of over 14,000,000 gallons in a week. From 1883, when the supply in London commenced, to 1893, about 1,750 hydraulic machines were connected to the mains, and the number is now about 3,700.

There is in the realm of the arts as in the realm of nature a struggle for existence always in progress, and in which the general law of the survival of the fittest is operative. The action of individuals and the fashion of the time may sometimes lead to great

prominence being given to one particular line of development, but in the long run the keen competition on every side and the necessity that requires the very best means to secure the industrial end in view will increase the continued use and development of all the various forms of energy which the bounty of nature and the skill of man have provided. Hydraulic power has been of the greatest value in industry in the past, and its future importance seems to be assured.

THE INFLUENCE OF ELECTRICITY UPON RAILWAY LOCOMOTION.

By B. H. Thwaitte.

THE offspring of George Stephenson's creative intellect, the steam locomotive, is at last, after an unchallenged supremacy of half a century, threatened by a formidable rival, the electric traction or propulsion system. Very few, even amongst statisticians, grasp the extent of the influence that Stephenson's invention has had in altering and improving the conditions of modern civilised life. In Great Britain and Ireland alone the capital actually expended on railways and their rolling stock and other accessories is very considerably over one thousand millions sterling, and the undertakings employ some 400,000 persons. If we allow three dependents to each person we have the colossal figure of 1,600,000 souls supported by the great railway system in Great Britain and Ireland. The gross earnings in the British railway system nearly attain the figure representing the British annual State revenue.

With such a record, it is not too much to say that everyone is, or should be, personally interested in any new application or discovery in science that tends to improve in speed, safety, economy and comfort, the working of our railways.

At the period when Stephenson's Rocket was built, the design of this application of steam power for tractive or propelling purposes was very creditable to Stephenson's inventive genius, but it is recognised by thermodynamists that, great as have been the modifications and improvements in the steam locomotive, this instrument of applied science cannot be considered a satisfactory thermodynamic motor, and, as a means of developing power from heat, it is a long way behind the instruments that have been designed for other branches of engineering. The modern locomotive weighs, in certain instances in European practice, as much as the entire train of carriages, so that half the power it develops and half the fuel it burns is used up in effecting its own propulsion. An indictment against the modern locomotive may be formulated as follows:—

Because of the necessity of securing sufficient tractive effort and adequate structural strength, the steam locomotive becomes enormously heavy. This ponderous mass, covering only one-fifth of the

total wheel base of the train, has to be allowed for in calculating the proportions of the entire permanent way, and the bridges involved in such construction. The steam passenger locomotive has not only to employ half its own tractive force to move itself along a level line, but, in addition thereto, it has to carry part of its own weight (including its fuel and its water) over heavy gradients.

Despite the great structural strength of its own framework the vibration of the engineering structure constituting the ordinary locomotive can not be prevented. This, combined with the atmosphere charged with sand, dust, and ashes, and the cooling influence on the steam cylinder that follows its rapid movement *en route*, acts in a very prejudicial manner on the moving organs of the engine, and tends to make its only moderate mechanical efficiency comparatively short-lived. The high figures of maintenance of the steam locomotive compared with those associated with high class stationary engines are obviously the result of the peculiar conditions that are inseparably associated with the locomotive type of steam engine.

The greater part of the surface wear of the rails can be justly debited to the adhesion and abrasion of the steam locomotive driving-wheels; but there is a still greater defect in this legacy of Stephenson's genius, and that is the reciprocating principle by which the energy of the steam in the cylinder is transmitted to the crank-axle of the driving-wheel of the locomotive. Any one who has travelled on the foot-plate of a locomotive, or who has witnessed the starting of a steam locomotive, will have noticed the variable motion of the crank as the connecting-rod drives it over the dead center. These variations follow all round the circle, so that on each revolution of the driving-wheels, vibrations are set up over the entire structure of the locomotive and are the cause of the pulsations that vibrate and shake the ordinary train from one end to the other.

The open air conditions, under which the locomotive is compelled to work, are directly opposed to highly economic fuel-efficiency possibilities, because the locomotive steam generator is subjected to the worst possible characteristics of the atmosphere,—rain, snow, frost,—aggravated by the high velocity at which the locomotive runs. Only those who have seen the iron horse enter, after its day's run, the cleaning shed, from which it emerged in the morning clean and bright, can realise how almost unrecognisable (in its begrimed and dirty state) a locomotive becomes in a day's ordinary run.

The imperfection of the efficiency of fuel combustion in an

ordinary locomotive need not be accentuated. Any one who has the misfortune to be compelled to travel on the London Metropolitan Underground Railway recognises this fact, of which he is too often and too painfully reminded.

Could a more striking example be exhibited of the ignorance and contempt for hygienic science than is shewn by the condition of the tunnels of the Metropolitan Railways of London? Probably in no other city in the world would the characteristics of the atmosphere of the tunnel between, say, Praed Street, and King's Cross, be tolerated for one single week; a great part of the existence of this filthy attribute of the subterranean railway system in London may be charged to the imperfections of the steam locomotive.

This indictment could be lengthened, but enough has been stated to prove that, although we cannot fail to gratefully recognise the influence that George Stephenson's invention has exerted in ameliorating the conditions of the life of the industrious masses, it still in its high state of development possesses fundamental defects of a very serious nature.

The beneficent science of electricity graciously offers us a means for tractive and propulsion work, to move our train-loads of passengers or of merchandise, by which, in addition to the removal of all the serious disadvantages to a great degree inseparably associated with steam locomotive traction and already enumerated, we obtain qualifications that have made the sometimes irksome necessity of travelling a real pleasure, if not a liberal education.

An Anglo-Saxon may be pardoned the glow of pride he experiences when the name of our most illustrious Faraday is mentioned as the real inventor of the application of a science, that, in its mature growth, under the care of devoted students of electricity, has become a rival, and is in the long run destined to supersede the outcome of Stephenson's brilliant intellect, the steam locomotive.

In this new instance of applied science for the benefit of man, America leads the way. In the United States, within the last few years, many hundreds of electric road or tram railways have been equipped with the electric traction system of propulsion or haulage: in these railways there are over 30,000 electric locomotors and 15,000 track-miles of electric conductors.

In Europe, up to the early part of the year, over 100 electric railways have been completed, of a length approaching two thousand miles and having maximum gradients with smooth rails up to 10.5 per cent. and with rack rails up to 35 per cent.

Nearly every country in Europe is taking kindly to the new electric locomotor, Germany occupying the premier position. France is second, whilst England, at present, takes the third place. Once foremost in all applications of practical science for the advancement of humanity, England has now too often to take a minor and receding position. It is, however, some consolation to us, with our essentially constructive character, to know that in the practical introduction of the new electric locomotor system to what is distinctly ordinary railway practice, we have examples that may be justly dignified with the great title of pioneer systems. The author refers to the City and South London Railway and to the Liverpool Overhead Railway, both of which are actuated electrically. Then followed the first electric railway established by Sir W. Siemens and connecting Bessbrook to the Giant's Causeway in Ireland. The first-named electric railway (The South London) was opened for public traffic on December 18, 1890; the yearly mileage of each electro locomotor, in regular running, it is said, exceeds 30,000 miles. Between the stations, of only a mile apart, a speed of 25 miles an hour has been attained. There are gradients 1 in 30 on the line.

Sixteen trains leave each terminal every hour, proving the absolute reliability and uniform working of the system. In the first three years' working this pioneer electric railway has carried fifteen millions of passengers.

This railway, except for certain immature details unavoidable in pioneer movements, has been an undoubted success; it may further be said, taking into account its enormous passenger record, to be as safe as it is popular. The Liverpool Overhead Railway has been equally satisfactory in its results.

Although the two systems described can not be closely compared with long distance railway work, we are nevertheless able to draw fair parallels between steam-power short-distance railways in the States and the Overhead Railway at Liverpool. The two American lines are the Manhattan, and the Brooklyn Elevated Railroads.

The cost of coal per one ton mile on the Electric Overhead Railway at Liverpool equals.....		0.020d
The cost of coal per ton mile on the Manhattan Railway equals		0.029d
The same, Brooklyn Elevated Railway, equals.....		0.038d
The average cost equals.....		0.0355d
Advantage of electric railway equals 67 per cent.		
The cost of supervision per one ton mile on the Electric Overhead Railway at Liverpool equals.....		0.014d

The same on the Manhattan Railway equals.....	0.036d
The same on the Brooklyn Railway equals.....	0.021d
The average cost equals.....	0.285d
Advantage of electric railway, therefore, equals 103.6 per cent.	
Total cost per ton mile, including supervision, motive power and train wages, coal, lubricants, stores, water, cleaning and repairs of rolling stock, on the Electric Overhead Railway at Liverpool, equals.....	0.1245d
The same on the Manhattan Railway equals.....	0.190d
The same on the Brooklyn Elevated Railway.....	0.152d
Average American steam locomotive practice equals....	0.171d
Overall advantage of the electric system, 37.3 per cent.	

This superiority, striking as it is, does not do full justice to the electric system.

Taking the actual train mile in lieu of the ton mile, the inferiority of the steam system represented by the two American lines (the nearest in general working to the electric one with which they are compared) for coal consumption is as 16 is to 41.

This train mile comparison is merely put forward to show that the ton-mile factors of superiority of the electric system are greatly excelled by the train mile record of comparison.

In the electric railway system the generating stations are equipped with high-class steam-power triple-expansion and condensing engines, absorbing little more than 2 lbs. of coal per actual horse power of energy for one hour. The entire plant is under cover, and is well cared for and not exposed to direct outside atmospheric influences nor to dust and ashes, which play such havoc with the actuating organs of the steam locomotive. One engineer adequately supervises generating power plant that will drive several trains, and the skilled-labour saving is consequently very great.

There is, of course, the loss in electric energy conversion and in its transmission of, say, 30 per cent., but, even then, the fuel for power applied to the axle of the train will not be more than 2.6 lbs. of coal per horse-power hour of actual tractive effort. The very best all round practice on English and Continental steam locomotives may be taken at 3.3 lbs.; whilst probably 4.5 lbs. is nearer the average general expenditure for actual horse power of actual tractive effort.

And, as we know that the weight of the steam locomotive is roughly one-half of the load of the train it has to pull, consequently this fuel expenditure has to be doubled, or, for each (actual tractive effort) one horse-power per hour, there is an expenditure of from 6.6

to 9 lbs. of coal, whereas, with electric traction, when the motors are placed on the carriage axles so as to distribute and extend the area of wheel adhesion, the fuel expenditure for the same tractive effort should not exceed 2.6 lbs., or an advantage in fuel efficiency in favor of electric traction equal to from 153 per cent. to 247 per cent. The author will shew further on, how this fundamental advantage can be still further increased.

Even in the Overhead Railway at Liverpool where the system of power generation in its efficiency is not thermodynamically very high, the consumption per train-mile varies between a minimum of 16 lbs. and a maximum of 22½ lbs. Whereas, on our first-class steam-locomotive railways, probably an average of 41 lbs. of coal would be nearer the mark.

This latter comparison is, however, merely an approximate one, because it does not take the load into account.

It can be demonstrated that, for passenger and express trains, the same speed results can be obtained with electric traction at a lessened cost of energy over that required for a steam locomotion of some 60 per cent. The speed that could be obtained with the longest and heaviest train of electrically propelled freight cars, would be very great, and the length of the long freight train would not involve additional locomotives, as it often does at present,—straining the constructional strength of the permanent way. The distributed load of the self-propelled electric freight cars, however long the train might be, would only produce the normal vibration and strains to the bridges.

The constructional railway engineer will welcome the disappearance of the reciprocating steam locomotive, the distribution of the freight load, more or less evenly, the great reduction of shunting operations (which play havoc with the rolling stock, as well as destroy millions of dollars' worth of freight per annum). The removal of the effluent gases and exhaust steam from locomotives, will immensely reduce the effects of corrosion on the steel and iron bridges, and also will prevent the injurious effects that follow the contact of the condensed water from the exhaust upon the masonry and joints of stone and brick tunnels and bridge-work structures of our railways.

Certainly the displacement of the steam locomotive by self-contained electric locomotive freight cars will mean the reduction of the depreciation factor of our railways by at least one-half.

The rotary movement of the electric motor destroys at once

some of the disadvantages that are the inseparable associates of the reciprocating steam locomotive, and there is, indeed, hardly a limit to the speed that could be obtained with an electric motor-driven train, whereas it is well known that there is only a somewhat limited range of speed with reciprocating engines. Further, the speed of an electric train need not vary more than 5 per cent., whereas the speed of a heavy steam locomotive on ascending gradients is very greatly reduced, even as much as 70 per cent. on stiff gradients. By simply altering the strength of the magnetic field in electric driven trains, the same speed within 5 per cent. can be obtained, on the rising gradient, as on the level track.

It is recognised, by progressive and unprejudiced engineers, that the modern steam locomotive, judged purely on its merits and without bias in its favour because of its historic associations, is an imperfect thermodynamic machine. Quite recently an attempt has been made to re-organise its construction by using high-class compound engines, and a new form of steam generator,—coupled to a greater innovation still, that is, of transmission of the power to the driving wheels electrically, so as to obtain uniform rotative motion by the application of equal energy impulses all round the driving-wheel circle, the crank element being eliminated.

The success of this last-named innovation in overcoming the disadvantageous pulsations of the reciprocating movement was proved in the initial trials to be most striking and complete. The author immediately after the trial received a letter from Mr. Charles Brown, of Bâle, who was responsible for the general design of the steam engine part of this singular arrangement: "It may interest you to hear that the big electric locomotive was started last Monday. It runs wonderfully sweetly, the disturbing influences of the reciprocating masses being entirely eliminated. No counterweights on the driving wheels but a steady tangential pull on the tyres.

"You can hold a glass full of water, standing on the driving platform, without spilling a drop or even producing a ripple on the surface. The movement is even less than on a first-class Pullman."

This innovation comes too late. The remarkable efficiency of high-pressure electric transmission enables the power generating stations to be located in the positions adapted for obtaining the best results and at the lowest cost. There is no reason why both

the goods and the passenger trains on the Great Central (Eastern) Line, on the Midland, as well as on the other first-class railways should not be driven by power generated at one central power generating station located on the coal fields.

But, if this innovation is considered too startling, power generating stations could be established every fifty miles along the line, the energy currents being supplied in such a way that there would be no break of continuity of energy supply. Power gas generating stations of, say, 5,000 horse-power each could be installed fifty miles apart to satisfy the traffic requirements on their particular sections. It may here be noted, that with such power generating stations, the power would only be developed as required. There would not be any appreciable stand-by loss, which is a source of great waste in labour and fuel in existing steam locomotive systems. Such electric power generating stations would permit of the generation of energy, under the best conditions for securing maximum efficiency with the highest possible economy, and if such power energy were developed by the direct combustion of fuel in internal-combustion or gas engines, driven by gas generated from common and low-priced fuels from which the nitrogen, tar, and other hydro-carbons have been removed, there is no reason, if we take the value of the ammonia in its equivalent of fuel, why one tractive horse-power of energy for a period of one hour would not be obtained for three-quarters of a pound of coal. This, compared with the system of power-generation employed in the Liverpool Overhead Electric Railway is equivalent to a saving of 60 per cent. And this advantage would be added to the already calculated and magnificent proportions of the figures of superiority of the electric system over existing European steam locomotive systems.

Besides this fuel saving, the reduction in skilled labour costs represented by a great reduction in the staff of drivers and stokers would be very great,—because each steam locomotive must have its own engineer and stoker, whereas one man of similar competence could look after several stationary power-developing engines located in one generating station.

In some of the electric tram-roads of the United States, such as those of New York, Boston, Chicago, St. Louis, and Brooklyn, magnificent central power generating stations of as much as 100,000 indicated horse-power will provide all the energy for electric traction over miles of tramways. The smoothness of running, the

characteristic of rotative driving, has in some of the converted electric tramways of the United States, increased the passenger traffic by as much as 30 per cent.

In the extension of the Electric Railway System, the lightness of the train-wheel-base enables very great prime-cost economies to be effected, both in weight of permanent way and in bridge-work. For goods traffic, in order to obtain sufficient wheel adhesion to provide adequate tractive energy, and at the same time to avoid dead load other than paying traffic load, three or four special 30 to 50-ton goods waggons or freight cars of steel construction, equipped with electric motors, could be employed, in each long goods or freight train, so that the load, carried by these self-propelling waggons or cars, whilst providing the necessary tractive power and adhesion, would still be a paying one, and not represent so much dead loss as it does at present.

For shunting purposes at the junctions, some of the existing steam locomotives could be brought into service during the period of transition from steam to electricity, because the application of the electric system with certain simple precautions need not in the least interfere with the running of the steam locomotives over the line during the period of metamorphosis.

The conversion of the existing railway system would involve the laying down of the usual central conductor rail on the existing sleepers, and the provision of cars in which the motors are placed direct on to the axle. The momentum of the train would carry it over level crossings, but other and simple expedients are available under such conditions, so as to avoid all risk of life. That the electric system is safer than the steam locomotive is proved by comparative statistics.

The cost of a given unit of power plant, laid down at the generating stations, would be much less than that involved in the construction of high-class steam locomotives. The electric system applied to our great railways would enable very light and cheaply-constructed electric telpherage or other electric branches, single or double, overhead, or level railways to be laid down so as to feed the main branch and trunk lines with inland traffic, and thus meet in an ideal way the requirements demanded in Great Britain to satisfy the promoters of the new light railway bill.

The advantages that would accrue from the reduction of the working expenses, particularly in the maintenance of the rolling stock and permanent way, would, in itself, more than justify the

application of the electric system to the main trunk lines,—if not to the branch ones.

Terminal accumulator-charging stations would permit the electric railway system to provide electric energy to their own cabs and omnibuses, as well as to traffic waggons, and similar accumulator stations located along the line, fed from the electric energy mains, would permit the supply of energy to lorries, carts, and other vehicles for the transport of agricultural and other produce to the traffic-receiving stations; and the electric energy can also be sold to the railway customers.

An ideal line,—say for the transportation of large and heavy masses of raw and manufactured products between an industrial inland centre and a port, such as, for example, between Manchester and Liverpool, Leeds and Hull, Birmingham and Gloucester, Pittsburg and Philadelphia,—would be an electric freight-car line, each car to be of, say, 20- to 50-tons' capacity and equipped with its own motors, each bogey to be independently electrically driven. The freight trunk-line to run as direct as possible, but to have lighter branch electric railways that would take the raw, and bring back the finished, materials to and from the distributed factories of the industrial district. These goods would, by electric machinery, be rapidly transferred to or from the larger steel electric freight cars.

The electric power-generating stations would be distributed along the trunk-line in such a way as to electrically serve the branch-feeding light railways, and provide all the electric power for the port-terminal warehouses, and for lighting purposes as well. Such an application would carry the raw cotton from Liverpool and bring back the finished cotton at such a freight rate as could not fail to secure an extension, of an indefinable period, to the life of the great cotton industry of Lancashire, and the same application would be as beneficial to the woolen trade of Yorkshire, to the hardware trade of the Midlands and to the iron and steel trade of Pennsylvania. There is hardly any definable limit to the range of useful possibilities of the new system.

The application of the electric system to the London Underground Metropolitan District Railways should at once secure the removal of the sulphurous and carbonaceous elements in the atmosphere of the tunnels that make travelling on these railways a positive martyrdom; this defect is, no doubt, primarily responsible for the poor success of the Metropolitan Railways and for the abject financial failure of the Metropolitan District Railway.

Unfortunately the City and South London Electric Railway, infinitely superior as it is in the clearness of its atmosphere, can not be considered so satisfactory as a hygienist could desire,—as the atmosphere of this tunnel has occasionally associated with it an odour peculiar to organic decomposition, and therefore, what would have otherwise been considered an unqualified success, is marred by a serious imperfection for which there is no apparent excuse.

Were the Metropolitan Railway Companies to adopt electric traction and dispense with their locomotives, except for shunting and other auxiliary purposes, and employ electric arc illumination throughout the tunnel systems, lighting the carriages from the outside (each train switching on the light as it passed along a section,) and to employ the entire length of the side of the tunnels for a suitable decorative form of advertising, the increased patronage that would accrue from the splendidly attractive metamorphosis of the system would amply justify the expenditure. The underground railway system of London would be relieved of the stigma that its grimy and filthy association has given to it, and the hearts of the shareholders would be gladdened.

THE IRON INDUSTRY OF SWEDEN.

By David A. Louis.

IN a previous article the writer has drawn attention to the extensive mining and ore shipping operations that are being carried on in Swedish Lapland and it is intended in the present paper to endeavour to convey some idea of the great iron mining and iron and steel making industry that flourishes in central Sweden; that very ancient home of these enterprises, some of which can be traced far back into the hazy periods of the pre-middle ages.

The sketch map Fig. 1, sets forth the area referred to and in it are the great ore fields, with the horizontal extent of the ore deposits in each expressed in square yards; Grängesberg, 108,000; Norberg, 36,000; Dannemora, 14,700; Striberg, 11,050; Persberg, 8,550; Stripa, 7,200; Kantorp, 7,200; Nordmark, 6,000; Strassa, 5,640; Pershyttan, 3,840; Finmossan, 3,480; Dalkarlsberg, 3,444; Sköttgrufvan, 3,336; Bispberg, 2,400, and others of lesser extent, making an aggregate ore area of considerably more than 45½ acres. In talking of the iron ore deposits of Sweden we must, however, remember the great deposits north of the area here depicted and previously referred to, and the great ore deposit to the south at Taberg in Imalund with an ore area of 312,000 square yards. The Taberg marked on the map, Fig. 1, is in Wermland and is remarkable for having the deepest workings of all Swedish iron mines, the depth reached however is only 1,200 feet; so Sweden although remarkable for great iron mines is not characterised by deep ones; the next deepest mine is 1,100 feet deep and is at Dalkarlsberg. All the other iron mines in Sweden are much shallower; in fact moderation, not exhaustion, is the keynote of Swedish mining policy.

Some idea of the productiveness of these mining districts may therefore be gathered from the following tonnages of production given roundly, because as yet the writer does not know the results of last year's activity; Grängesberg, 660,000; Norberg, 140,000; Dannemora, 50,000; Striberg, 40,000; Persberg, Stripa, Sköttgrufvan and Dalkarlsberg between 35,000 and 25,000; the rest producing less than 20,000 tons a year.

These iron ore deposits occur in archæan rocks as lenticular masses, and appear to be bedded; generally there are several such

masses together, as the writer pointed out is the case in connection with the Gellivan deposits. The masses vary in size from a maximum thickness of 300 feet in the Grängesberg mines down to 30 or 40 feet, or even $6\frac{1}{2}$ feet for such deposits are deemed worth working. The length of a chain of deposits is, however, very great in many instances; for example at Norberg the longitudinal extent is nearly 22,000 yards, at Grängesberg about 4,500 yards, at Riddarhyttan more than 3,800 yards and at Dannemora not far from 2,200 yards. The ores obtained are both magnetite and haematite and their character and that of the accompanying gangues may best be exhibited by quoting some of the

Name of Mine	Oxides of Iron			Manganic Oxide	Sulphur	Iron	Phosphorus	Silica	Alumina	Lime	Magnesia
	Fer-ric	Mag-netic	Fer-rous								
Bispberg	2.30	95.4		0.4	0.006	70.7	0.0045	0.4	0.1	1.4	0.3
Dalkarlsberg	51	29			trace	56.7	0.06	12.3	0.6	2.6	4.5
Dannemora..... }		71.7	0.7	2.27	0.038	53.5	0.003	9.3	1.5	5.2	5.6
Middle Portion.. }											
Finmossan }		79.6				57.7	0.01	8.5	4.3	3.3	3.8
"Bruten" }											
Grängesberg }											
North Part }	73.5	14.8		0.04	trace	62.2	1.54	1.6	0.6	5.1	0.3
Kantorp }											
"Nymans" }	1.2	92		0.3	0.023	65.2	0.007	3.0	2.1	0.3	0.7
Norberg "Ostan- mossgrufvan" }		53.6	20.1	0.3	0.03	53.2	0.007	14.1	1.6	4.1	6.5
Nordmark }											
"Nygrufvan" }		68.6		0.6		49.6	0.01	16.0		6.4	5.8
Persberg }											
"Storgufvan" }	55.2		23.8	0.2	0.02	57.2	0.0033	10.5	2.4	5.2	1.9
Riddarhyttan..... }		75.6	5.0	0.6	0.06	58.6	0.006	10.8	3.6	1.4	2.5
Striberg Åsbo- bergsgrufvan }	81.2	5.0		0.1	0.016	60.4	0.032	5.8	3.3	2.4	1.4
Ställberg..... }		64.2	6.17	7.43	0.044	51.3	0.009	8.0	2.3	2.6	3.1
Tarberg }											
Wermland }		71.8		0.14		54.4	0.008	14.4	0.4	1.0	6.1

analytical results that have been published by Professor Nordenström.* The numbers are per cent.

These numbers give some idea of the diversity in character of the ores, obtained at various parts of the area under consideration, but it must be noted that there are some three hundred mines in the district and that the composition of the ore, even in the same mine varies to some extent and there is of course variation between one mine and another. But the general characters of the produce of each mine remain fairly constant, that is as regards the proportion, generally so

* *Journal Iron and Steel Institute*, Vol. II., 1898.

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low, of phosphorus and sulphur, the amount of silica or lime or magnesia in the gangue, and the haematitic or magnetic character of the iron ore itself; which fact enables the manufacturers of the district to rely on the supply of ore for making the delicate blends necessary in producing the special brands of high class material for which each of them is celebrated. Hence it is that running round the iron works of Central Sweden, the produce of certain mines are observed to be particularly prized at particular works. For instance at Laxa at the time of the writer's visit they were using ore from

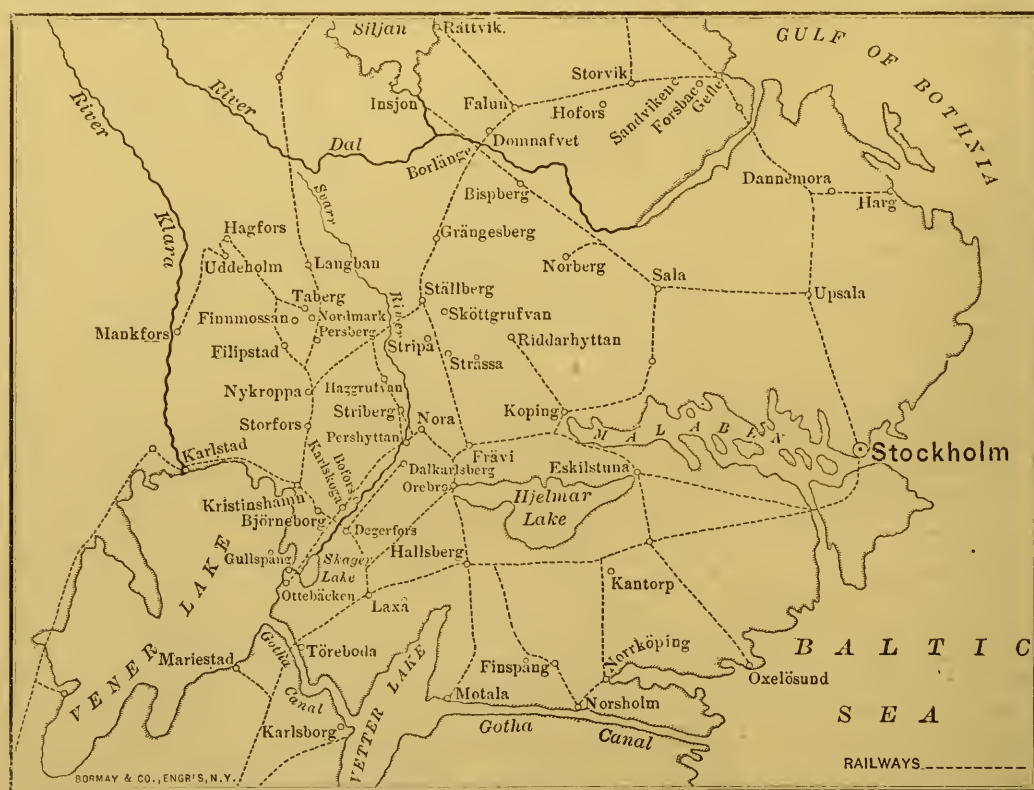


FIG. 1. SKETCH MAP OF SWEDISH IRON DISTRICTS.

Dalkarlsberg, Striberg, Kantorp and Sköttgrufvan. In many cases too the proprietors of the works are the largest shareholders in the mines from which they draw the ores they require. The efficient network of railways shown only in part in Fig. 1 facilitates distribution and renders this beneficial disposal of the produce of the mines possible. It may further be noticed that the railways not alone connect the mines with the works but they also connect both mines and works with great waterways, the Gotha canal, the Gulf of Bothnia, and the Baltic seaboard, and not alone does much of the manufactured product thus find an easy outlet to foreign shores but also

a great quantity of ore leaves Central Sweden to be used in other countries. This is particularly the case with the phosphatic ore of Grängesberg, which is shipped at Oxelösund on the Baltic Sea. Some of the mines are still worked open-cast, such a working is shown in Fig. 2. It represents an open-cast working at Grängesberg, which now extends below the surface level and is worked in stages; from each of which ore is trammed to the base of a special shaft in the country tapping that level, thence it is wound to the surface; it is then taken along a gantry and tipped into railway wagons as shown in Fig. 3. The pyramidal structures shown to the left of Fig. 3 are the covered headgear of the shafts that serve the different levels. Where open-cast work is not applicable both overhand and underhand stoping are in vogue, the preference now-a-days being given to the former, with filling. Some of the stopes are very big—40 to 50 feet wide—and at Dannemora even 100 feet wide; for this reason and some others power drills have not made much headway in Sweden, but there seems little reason to doubt that the next few years will see a great alteration in this direction. Be that as it may, the hand drilling is excellent in spite of the fearful hardness of the work. Some stoping is still done without filling but no great proportion of the whole, however, vast underground caverns still open show how extensively this method of working has been employed in days gone by. A prominent feature of the mining districts of Central Sweden is the great number of deep gaping ravines and chasms, the remains of the old-time open-cast workings, with here and there some of the old covered winding gear still about. Another striking feature is the system of overhead travelling rods, painted red, used to convey power from the water-wheels to the pumping, hoisting, or other gear. Their day is doomed with the introduction of the electrical transmission of power, but now they are encountered, here and there, across country; always moving backwards and forwards and always groaning piteously as if aware of their doom. With regard to the treatment at the mines, by far the greater portion of the iron ore as it comes from the mines in Central Sweden is simply subjected to hand-picking before sending to market; but where this does not suffice the practices usual elsewhere are introduced, such as cobbling with or without washing and picking; systematic screening and washing with or without crushing, and magnetic separation for the small stuff.

Turning now to the disposal of the ores, they as already stated, find their way either to neighboring works or to ports for export. In

the former case they are converted into metal on the spot and the general practice is as follows:—The raw ores are calcined in kilns heated by the blast furnace gases, and if necessary, the calcined ores are crushed. They are then stored in bins around the top of the blast furnace, each particular ore in its special bin. Here may be seen one of the most important operations in connection with the production of the various excellent brands of Swedish iron; that is the blending of the ores for the charge, and their distribution over the fuel in the furnace. The fuel, charcoal, is charged in direct from skips, then the ores are taken in regular order and stipulated quantities being most carefully weighed out in a scoop suspended from a steelyard that travels on a swinging crane-arm, which commands the whole top of the furnace, and by means of which each lot of ore or flux is distributed in a systematic fashion, that is quite astounding to watch. The mixture employed differs materially at various works and sometimes a great number of ingredients are included in the charge. At Hagfors for instance, at the top of the blast furnaces there were no fewer than thirteen bins with the quantity to be used marked on each; two of these were flux bins, and the rest were ore or cinder bins. The blast furnaces visited varied in construction and were about 50 feet in height with a diameter of about 7 feet at the throat, 10 feet at the boshes and 5 feet at the tuyeres, they are worked steadily to produce about 100 tons a week with a blast at about $1\frac{1}{2}$ lb. pressure heated in pipe stoves to 200° C. for Lancashire pig and 300° to 400° C. for open hearth and Bessemer pig, and a consumption of about an average of 17 cwts. of charcoal per ton of iron produced. The iron is generally run into chills for pigs or into the ladles for Bessemerizing, but in some instances casting in sand is in practice, at Bofors, for instance.

A large portion of the output of pig is destined for conversion into wrought iron in the Lancashire hearth although the Walloon process and the puddling furnace are used to a slight extent, whilst the Bessemer and open-hearth processes claim their quota. The accompanying table, from Professor Akerman's paper,* shows the relative positions of these processes occupied at the beginning of last year.

It is a quaint and attractive sight to see a battery of these Lancashire hearths at work with the shingling going on under tilt hammers; it seems to take one back to legendary days, but there is no doubt that the work required by the Swedish ironworkers is well

* *Journal Iron and Steel Institute*, Vol. II., 1898.

done by this method. Moreover, Mr. Y. Lagerwall has invented a contrivance for breaking up the ball mechanically which not alone greatly increases the output per hearth but also diminishes the consumption of charcoal and loss of iron; according to Ackerman (*loc. cit.*) the weekly production per hearth is now 14 to 20 tons of blooms with a waste of 7 to 15 per cent. and a consumption of $2\frac{1}{2}$ to 4 cubic meters of charcoal per ton of metal charged. Lagerwall's contrivance consists of a horizontal bar extending along and parallel with the front of the furnace fixed between two arms that work in bearings attached to the furnace. The arms are of such a length that the horizontal bar when up may be brought well above the fire opening and when down is at about the level of the table, so that when motion is given to the arms the horizontal bar takes a curvilinear course and approaches and recedes from the fire. Motion is transmitted to the arms by means of a link that connects one of the arms with the lower end of an eccentric rod working from overhead

		Metric tons.
Wrought iron	{ Lancashire	177,525
	{ Other charcoal hearth methods	10,188
	{ Puddle bars	1,919

Total		189,632
Ingot iron and steel	{ Bessemer	107,670
	{ Open-hearth	165,836

Total		273,515

DISPOSAL OF SWEDISH OUTPUT OF PIG IRON.

shafting, and to utilize the motions of this bar the rabbling-iron is provided with a lug which is placed so as to engage the bar at the commencement of its downward stroke; the tool in this way being carried forward into the fire, without scarcely any effort on the part of the man, who simply has to guide the implement, and the work is done not only with less expenditure of manual labour, but also more efficiently, effecting a saving of both time, fuel and metal. The ball is ultimately bloomed under a tilt hammer, rolled into billets and taken to the mill re-heating-furnace. The re-heating furnace mostly encountered in Central Sweden is Ekman's gas furnace; which is fired from one end, whilst the billets are charged in at the cooler end and gradually advanced to the hottest part, the working is commonly continuous, but re-heating furnaces with automatic firing devices and mechanical appliances were also seen. Some of the pig iron, however, is used for steel making and for Bessemer steel is taken directly from the blast furnace in molten



FIG. 2. ORE LOADING FROM THE SHAFT.

condition, and is worked in the usual way. When casting, however, the Casperson converter ladle is in some cases made use of. This consists of a small cylindrical ladle having at the side near the bottom a horizontal limb that can be attached to the mouth of the converter by means of lugs and wedges, the metal can then be poured direct into the moulds without the intervention of the ordinary ladle and crane. The advantage of this is the conservation of heat, which is of much importance; in this practice however the hole is fixed and therefore the ingot moulds are arranged in a turntable and brought up in succession. Swedish open-hearth practice is generally much the same as elsewhere with slight variations. At the Hagfors works of the Uddeholms Aktiebolag, for instance, the ladle was provided with an electric motor and ran on overhead lines, below which the moulds were hung on small train trolleys to be filled two at a time.

In the various Swedish mills visited, all kinds and sizes of rolls were to be seen; two high, three high, universal, reversible and tube mills. They were in a few cases operated by steam, in others by water-power; each train of rolls being sometimes provided with its own turbine, as at the Degerfors Steel Works, other times an engine being used to give the motion, and in some cases electrical

transmission has been introduced. Both hot and cold rolling are to be seen in central Sweden, the latter for instance at Sandviken and at Munkfors, the former at all works. Amongst the products of the works are both pig and ingot metal, bars, rods, plates, sheets, hoops, hollow blooms for weldless tubes, and the tubes themselves; tires, nail rods and nails, wire rods and wire, umbrella ribs, bicycle spokes, springs, saw blades, wood screws, horseshoe nails, and superior qualities of steel of all tempers for special purposes. The Swedish iron and steel manufacturers are keenly alive to adapting their practice to the requirements of the times and the insight into their practice obtained during this recent visit to their works producing the various objects just enumerated, clearly demonstrated that not alone do they appreciate but also readily avail themselves of the experience and discoveries of other countries to achieve their ends. They utilise liberally and to a large extent the appliances produced in other countries, therefore splendid examples of machinery and machine tools from America, Germany and England, were constantly encountered in many of the various places visited. These included: The Gängesberg mines; the Domnafvet iron works; Falun mines; the Hofors iron and steel works; the Sand-



FIG. 3. GENERAL VIEW FROM NORTH OF BERGSBO MINE.

viken steel works; the Forsbacka steel works; the Skutskär saw mills and cellulose factory, and the Dannemora mines of one group; and by the other group: The Laxa iron works and cellulose factory; the Degerfors steel works; the Uddeholms Aktiebolag works at Hagfors, Råde and Munkfors; the Storfors Bruks Aktiebolag at Nykroppa; the Persberg iron mines and the Bofors iron and steel works and the Bofors ordnance factory, the latter as exhibiting a special feature will be selected for some special notice. It may be noted as an example of the employment of foreign machinery that at Hagfors a specially fine display of American and

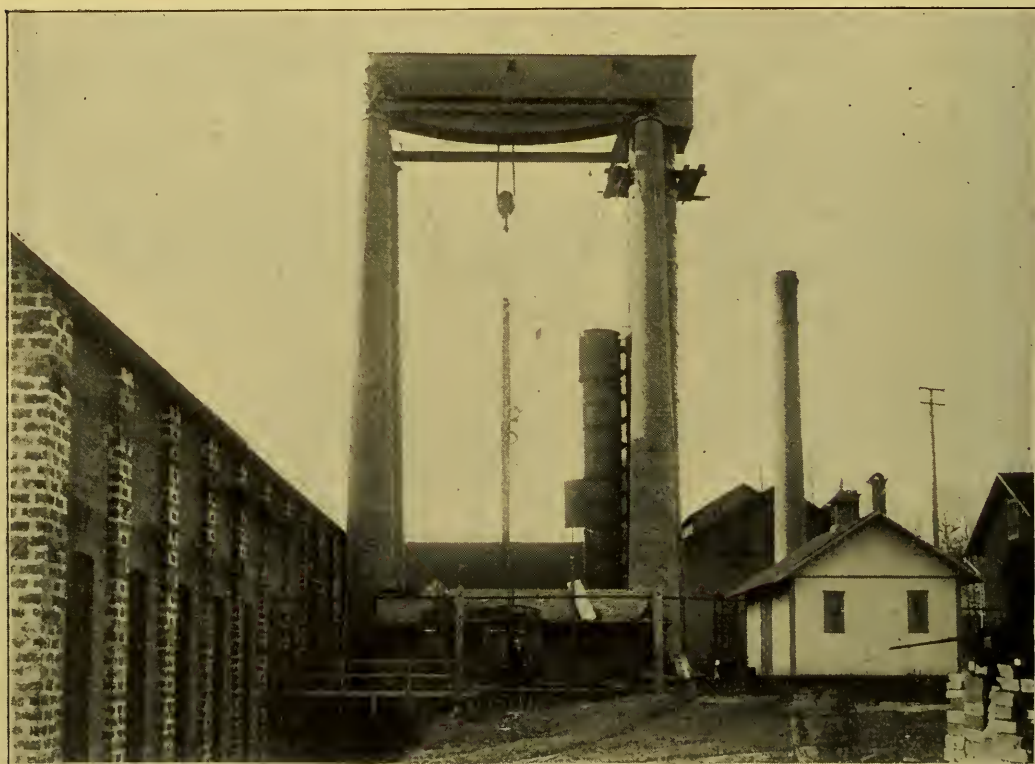


FIG. 4. BOFORS-GULLSPANG. CRANE AND TOWERS OVER HARDENING FURNACE.

German automatic nail making and screw cutting machinery was seen in operation; and further it must be observed that the Swedish folks themselves are by no means behind hand in developing this department of the iron and steel industry, and produce excellent machines of their own but, nevertheless, are as we have seen quite willing to recognize and employ the produce of foreign talent and genius.

As the conspicuous features of the mine of Central Sweden are the headgear, the chasms, and the travelling rods, so at the works are the waterpower, the blast furnace and calcining house and the

fuel-house. The last mentioned are well ventilated structures of great dimensions; their presence and magnitude is required owing to the fact that the fuel, charcoal, is so very bulky and moreover, can only be brought out of the woods in the winter and then only when there is snow for sleighing, so the works have to insure a provision of charcoal to cover three quarters of the yearly requirement. There being no coal at the iron centres of Sweden, charcoal is the only fuel used and this accounts for Sweden restricting itself to a comparatively small production of iron of high quality and its not competing in the heavy iron trades. In Sweden too the blast



FIG. 5. HARDENING FURNACE IN ACTION.

furnaces and the calcining kilns are housed in, forming, whether housed together or separately, very conspicuous objects and with the coal-house and the connecting trestle inclines or bridges making a strikingly characteristic group of structures. The water-power is another special feature of the works of Central Sweden, and not alone does it compensate for the want of fuel but for that very reason the geographical position and distribution of the works is entirely due to this factor, and in times gone by, when only small water-powers could be dealt with only small works were possible. Now,

when larger water-powers can be controlled and utilised the movement is in the direction of the abandonment of small works and the centralisation of operations in large works, a policy that will be still further developed with the spread of electrical transmission, which has already found ardent advocates in some of the works visited. There is an excellent water power at Degerfors, which even in the driest seasons will supply 1,200 cubic feet of water per second with a fall of 25 feet, and a dam was being constructed to render a minimum of 4,000 h. p. over both at all times. Other works too have splendid water-powers and at Munkfors it takes the form of a fall which is both high and beautiful although not of such magnitude as Trollhättan.

All the works visited, with the exception of one, were working more or less on the lines just sketched out, and that one is no exception, so far as its production of pig and wrought iron are concerned, but it has struck out an independent line in connection with its open-hearth industry. The works referred to are those of Aktiebolaget Bofors-Gullspång. Its exceptional operations are the result of the development of the Terre Noire method of manufacture of cast steel ordnance, operations that are also conducted at Finspång which although included on the sketch map Fig. 1, was not visited by the writer.



FIG. 6. BOFORS GULLSPÅNG. WEST SHOPS.

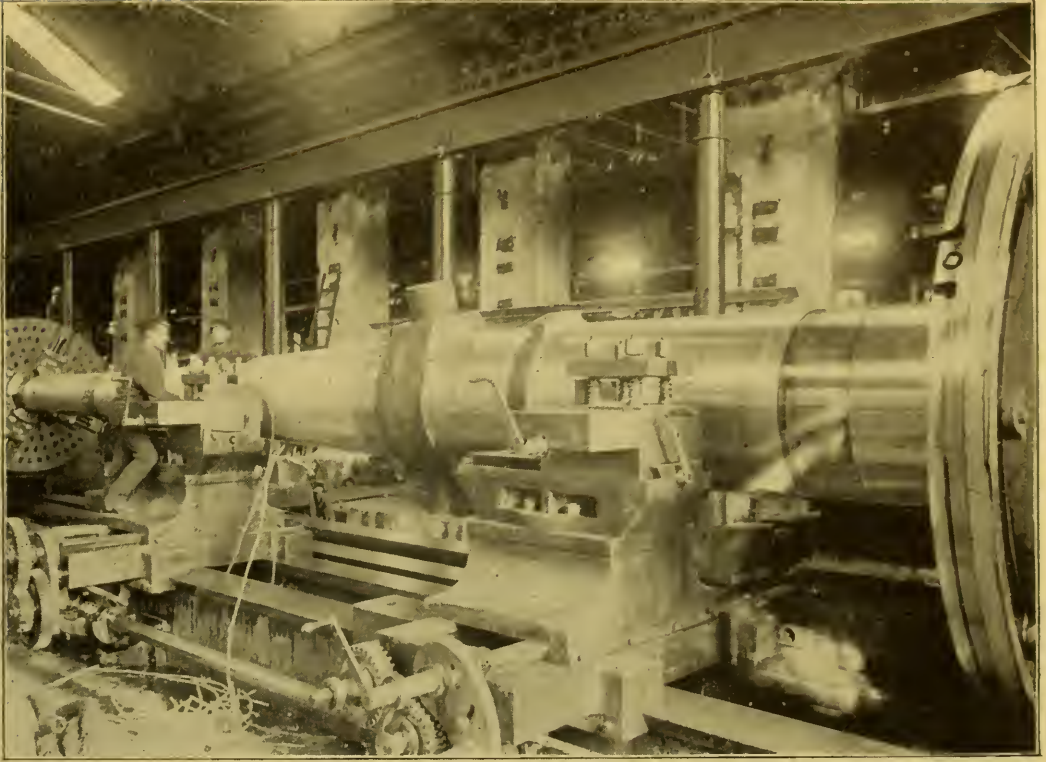


FIG. 7. BOFORS-GULLSPANG. GUN LATHE. CAPACITY FOR GUNS OF 32 CM. BORE, 50 CALIBRES.

It must be remembered that owing to the great care bestowed on the management of the blast furnaces, up to thirty years ago, all guns in Sweden were cast directly from the blast furnace, and the practice was simply discontinued owing to the difficulty of getting pig iron in sufficient quantity for the demands of the heavy guns now common.

The undertakings of Aktiebolaget Bofors-Gullspang are the present representatives of iron industries which have been in continuous activity since the fourth decade of the 17th century. They remained in comparative insignificance for two hundred and thirty years until under the ægis of the immediate predecessors of the present company considerable extensions were made and brought the works into some prominence. The present company was established in 1873 and has adopted and maintained a continuous career of progress and improvement, they now own works at Skjagersholm, Bofors, Björkborn, Björneborg and Gullspang most of which are shown on the sketch map Fig. 1, but of these only Bofors was visited. It is on the Nora-Karlskoga line, whilst the other title name is at the mouth of the river Gullspång that connects

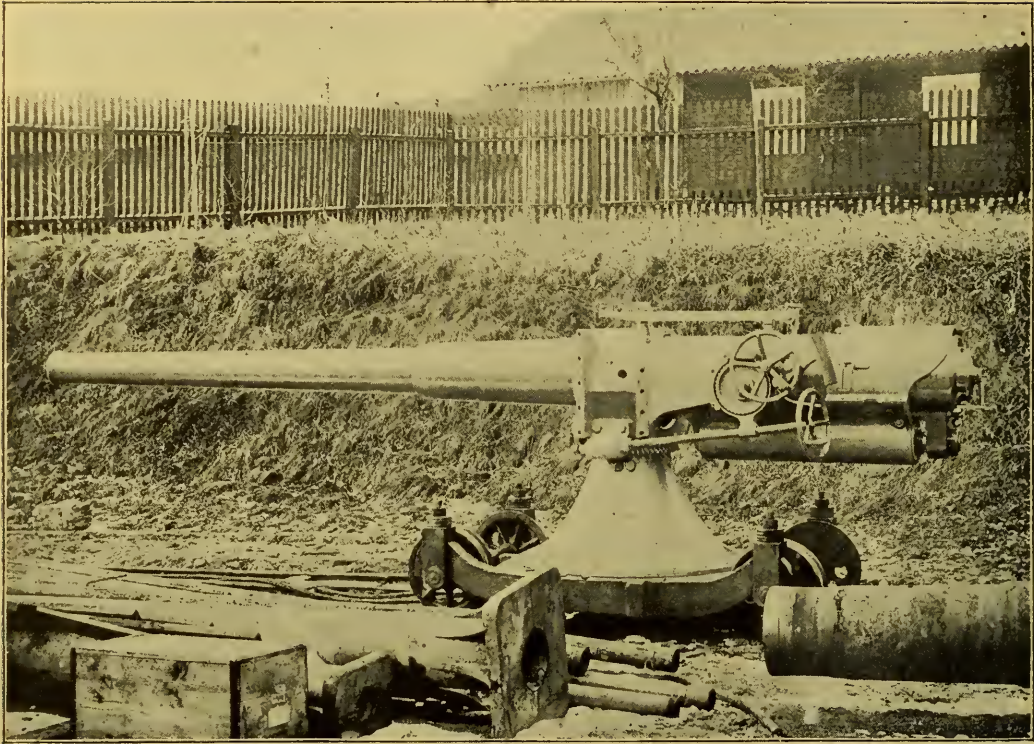


FIG. 8. BOFORS-GULLSPANG. 12 CM. 45 CALIBRE RAPID-FIRE CANNON.

Lake Skager with Lake Vener, navigation between the latter and Gottenburg or Stockholm being along the water courses connected by the Gotha Canal. The Bofors works at present comprises 1 blast furnace with calcining kiln; two open-hearth furnaces, one 10 and one 5 tons; thirteen Lancashire hearths for making charcoal blooms; five rolling mills for bars, rods, hoops and sheet; a steel foundry and an ordnance factory. The blast furnace is 50 feet high, 9 feet at the boshes and 4 feet in the crucible; the ores used are from Striberg, Haggrufvan and Persberg mines, and the output is 100 to 120 tons of pig a week, the consumption of charcoal being from 17 to 19 cwt. per ton of pig; which is converted into malleable iron in the Lancashire hearths and is worked up in the mill. The latter is kept busy on iron alone as practically all the steel is consumed in the foundry.

The steel works and foundry are of some size, as may be gathered from the fact that the latter is capable of accommodating very big work; a casting 16 metres long was made there and after cutting off 6 metres, as a head, was used for a 10-inch gun which is shown on the lathe in Fig. 7. All the well known precautions are taken to ensure a casting without blow holes. A casting was made in the

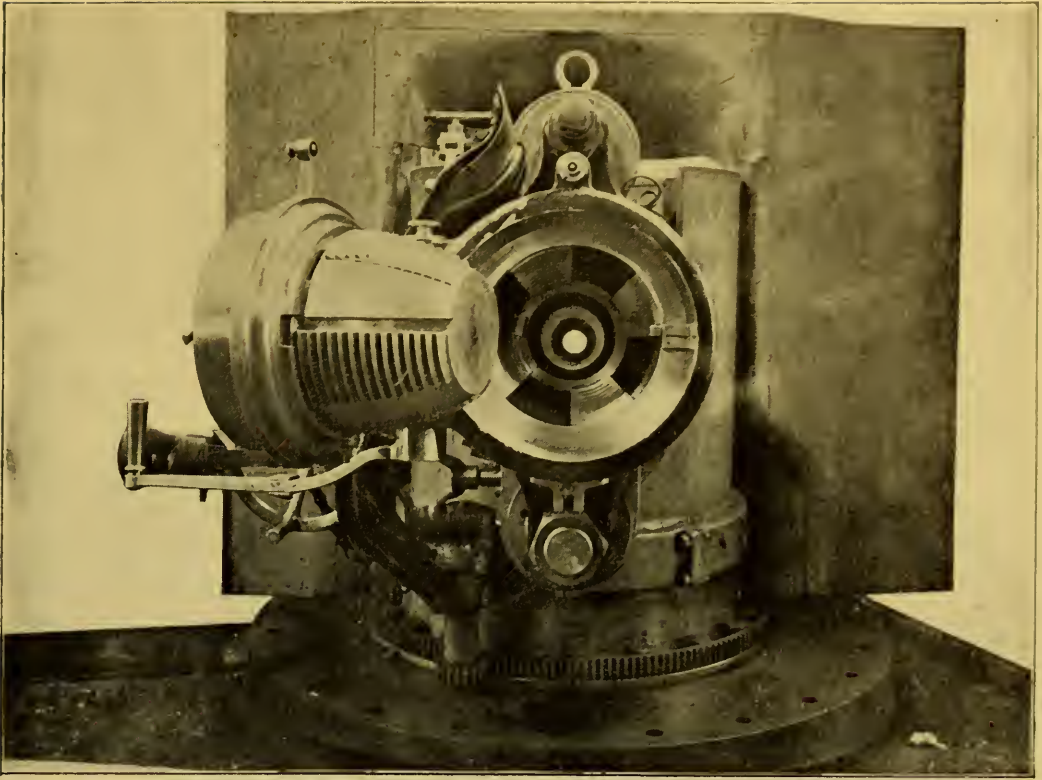


FIG. 9. BOFORS-GULLSPANG. 12 CM. RAPID-FIRE CANNON, SHOWING BREECH MECHANISM.

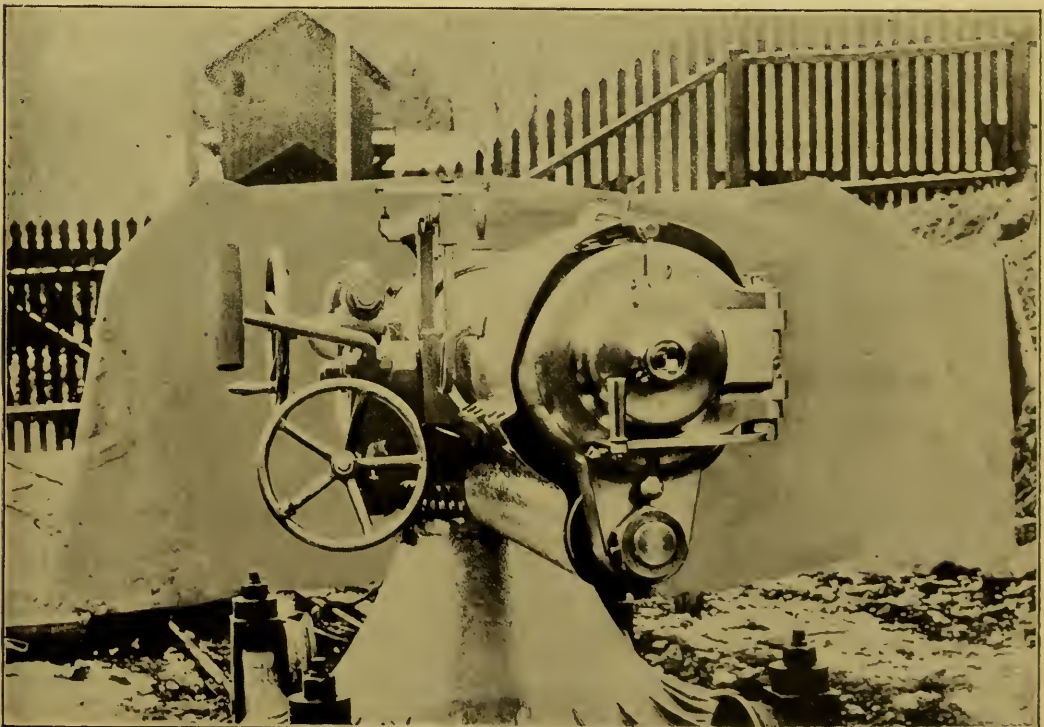


FIG. 10 BOFORS-GULLSPANG. 12 CM. RAPID-FIRE FIELD CANNON.

presence of the visitors; the furnace was tapped by means of a two-way spout, put into one and then into a second ladle, which was then manipulated by cranes, adjusted over the work and casting from both proceeded with simultaneously, the operation being completed with great expedition; in spite of the character of the object, which was a 12-ton ring for the base of a big gun. Two similar rings were seen, one in the yard and the other on a lathe where the excellence and magnitude of the work could be appreciated. Figs. 11 and 13 show other castings from this foundry; the latter is a stern post



FIG. 11. BOFORS-GULLSPANG. PROTECTING SHIELD FOR 30.5 CM. CANNON.
WEIGHT, 15 TONS.

and weighs over 12 tons; the former is an armour plate cast shield for a 12-inch gun and weighs 15 tons. Fig. 12 is the ram of the armour-clad "Thule" and weighs more than 9 tons.

The Bofors ordnance factory covers a great area with numerous shops, sheds and yards, all connected by a railway track. The shops are good structures nicely arranged, well lighted, and excellently equipped with lathes and other machinery. Fig. 6 shows one of the shops with a cast steel propeller slung in the background and another on the lathe in the foreground; whilst Fig. 7 furnishes

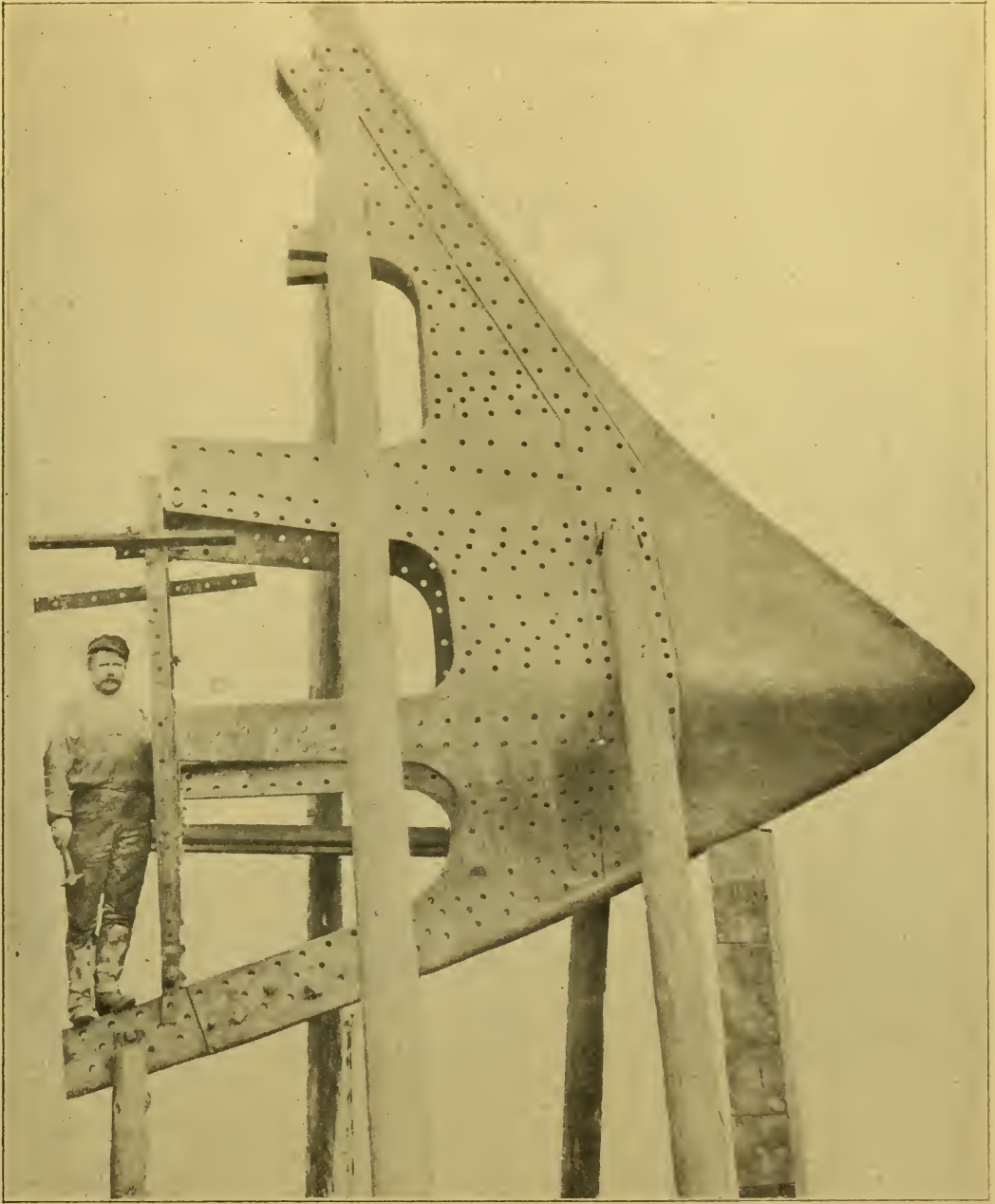


FIG 12. BOFORS-GULLSPANG. RAM FOR PROTECTED CRUISER THULE.
WEIGHT, 9,170 KILOGRAMMES.

another example of the capabilities of these shops. Armour plates are cast at Bofors up to 20 tons in weight and are, if necessary, bent cold in a 1,000-ton hydraulic press to any desired curvature, an operation that was witnessed at the time of our visit on a plate $3\frac{1}{2}$ inches thick. Projectiles are also made at Bofors; but undoubtedly the most prominent work of the ordnance factory is connected with guns. These they make of various calibres, that in Fig. 7 is a 10-

inch, whilst Figs. 8, 9 and 10 show $4\frac{3}{4}$ -inch quick-firing guns. Fig. 8 is a side view of the $4\frac{3}{4}$ -inch naval quick-firing gun of 45 calibres, which has the following data, these are given in metric quantities, inasmuch as they then accord with the registered measurements and gauges: Calibre, 120 millimetres; length of gun, 5,400 millimetres; number of grooves, 36; each one millimetre deep, 6.97 millimetres wide and separated by bands 3-5 millimetres wide; twist at breech, 60 calibres; at muzzle, 30 calibres; weight of gun, 2,800 kilos; weight of carriage, 1,700 kilos; capacity of bore and chamber,

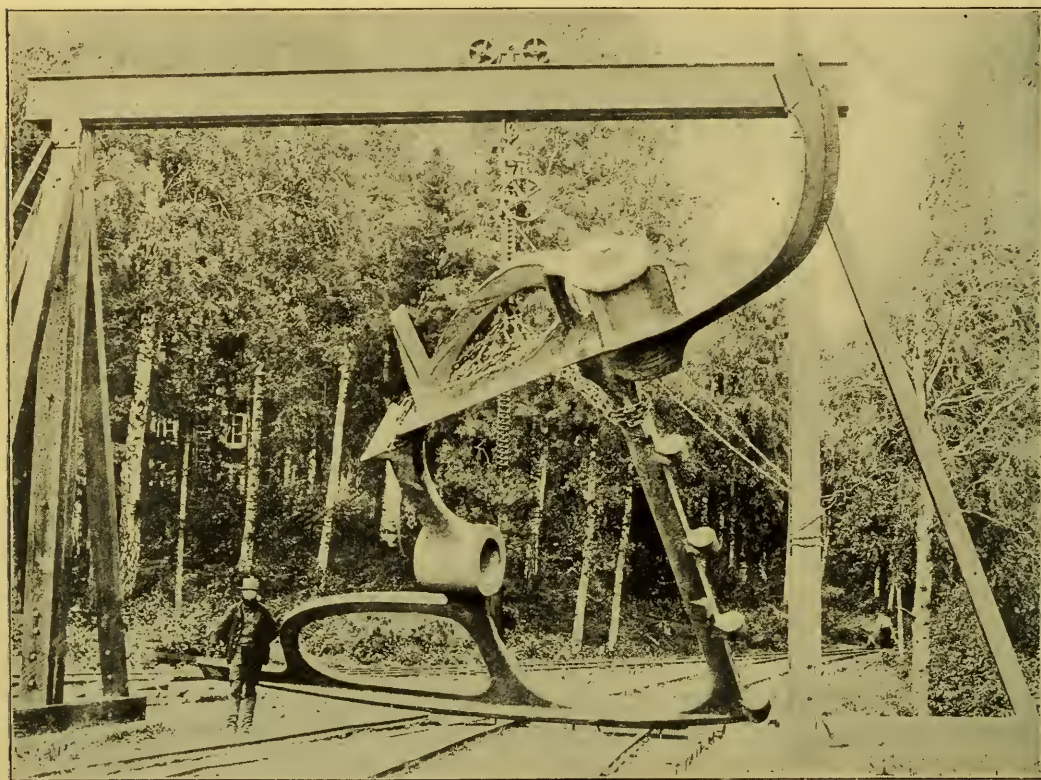


FIG. 13. BOFORS-GULLSPANG. STERN POST AND RUDDER FRAME FOR ICE-BREAKING BOAT. WEIGHT, 12,200 KILOGRAMMES.

60.6 litres; of cartridge case, 6.42 litres; weight of projectile, 21 kilos; of charge, 4.20 kilos; capacity of cartridge case per kilo of powder, 1.53 litres; muzzle velocity, 793 metres; muzzle energy, total, 671 metric tons, per kilo of powder, 160 metric tons, per kilo of gun mass, 240 metric kilos; range with elevation of 17 degrees, 9,150 metres; velocity of projectile at 1,000 metres, 654 metres, at 2,000 metres, 534 metres; perforation of wrought iron at muzzle, 39 centimetres, at 1,000 metres, 30 centimetres, at 2,000 metres, 22 centimetres; length of recoil, 240 millimetres. Fig. 9 shows the breech view of the same calibre quick-firing gun in armour plated carriage,

it also shows the rifling, the cover and the breech mechanism. Fig. 10 shows the same calibre quick-firing field-gun with the breech closed. The spiral screw used in the closing gear has the advantage that it can be swung aside after turning it $\frac{1}{8}$ of a turn on its axis, whereas a cylindrical screw requires many turns before it can be swung aside; the firing mechanism is contained in the cover, to which, however, space will not permit further reference. It may be added that the Bofors-Gullspang company also make the gun-carriages, limbers, implements, ammunition wagons, etc., and that Bofors guns, projectiles and armour plates have been submitted to the severest tests and have acquitted themselves well, as shown by published reports of such trials.

One of the most costly and at once the most imposing looking appliances connected with the Bofors ordnance factory is illustrated in Fig. 4; it is for re-heating and oil-tempering gun-tubes. The superstructure, as will be seen, consists of the brick columns some 70 feet high supporting a gantry upon which rests and works a 50 ton electric crane which is covered in; whilst extending some way up on the right hand side is the vertical re-heating furnace, the lower part of which is hidden by the house that is built around the top of the oil well situated beneath the centre position of the crane, and which is 50 feet deep. The re-heating furnace is provided with a series of doors, on the side facing the well, one of which is shown open in the figure; these serve for the admission and removal of the gun-tube and are closed during the heating. The heating is effected by gas firing from a number of gas nozzles provided for the purpose up the back of the furnace and the progress of the heating is followed by means of a mirror placed at an angle of 45 degrees in a pot below the furnace. The gun-tube is suspended in the furnace and moreover, generally manipulated with the greatest facility by means of the electrical crane. We had an opportunity of seeing it actually at work. The furnace was opened in our presence, the hot tube withdrawn brought over the well and then plunged into it; when the magnificent spectacle, but feebly depicted in Fig. 5, presented itself to our appreciative gaze, recalling to the writer an oil well on fire, and forming one of those striking factors that help to keep the memories of a visit green in one's mind. In years to come we shall be saying, Ah, yes! the place where we saw the fountain of fire and smoke in Sweden.

METHODS OF REMUNERATING LABOR.

By P. J. Darlington.

AT the present time engineering societies and manufacturers are giving a great deal of attention to discussions of "piece-work" and "premium" systems for machine building works in the employment of their workers. All of these systems are primarily for obtaining the lowest possible "wages cost" and "equipment cost" per piece produced, without loss in quality of product, excessive wear and tear of equipment or friction with the workers, and all involve offering extra pay for extra effort on the part of the worker.

The most important of these systems are (1) "Piece work," or the payment of a fixed price per piece produced, previously agreed upon between works and worker.

(2) "Piece rate," or the payment of a price per piece produced, depending upon the speed of production, in a manner previously agreed upon. Up to a specified number of pieces per hour, a low price per piece is paid, but when the speed of production has passed the specified point, the "piece-rate" is increased, not only for the remaining pieces, but for all thus far completed on that contract.

(3) The "Premium" system, in which the worker is paid a fixed rate per hour, until his speed of production has passed a specified point, after which he receives, on the additional pieces per hour, a small price per piece in addition.

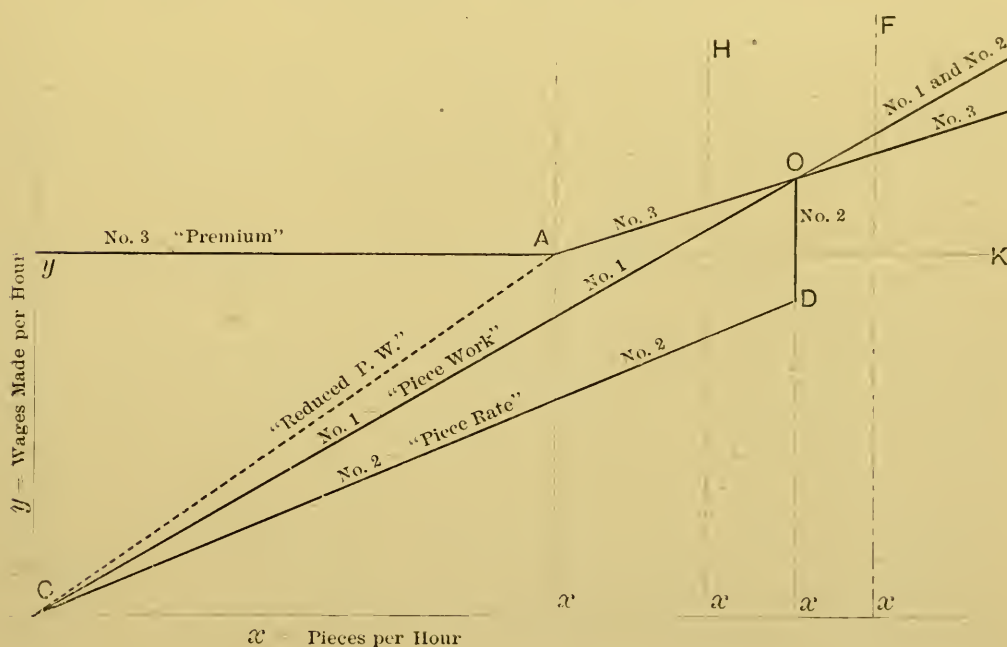
The accompanying diagrams on the basis of pieces produced per hour and wages made per hour, will clearly illustrate the three systems. In these diagrams the "Wages-cost" per piece at any output (X) and wages made (Y) is $\frac{Y}{X}$ or if a line be drawn from the centre (C) through any point on the diagram, the greater the angle which that line makes with the horizontal, the greater the "wages cost" per piece ($\tan.$ of angle) at that particular speed of production in that system.

The angle which the diagram itself makes with the horizontal at that selected point, represents the "immediate" incentive $\left(\frac{dy}{dx}\right)$ or reward offered the worker for increased speed of production, while the "total" incentive is the difference in his present wages per hour and that which appears to him attainable by increased effort.

In order to apply these diagrams to the comparison of the three systems, we may assume the following:

In a particular machine shop job, the point (A) represents the hourly output and “wages cost” under the old “day work” system. The point (O) represents an assumed attainable increase of speed of production, and the necessary increase of wages as incentive to procure it. Assuming that this point can be reached by either of the three systems, we draw all the diagrams through this point and we are now prepared to study the action of the different systems in producing equal results.

“Piece-work” (Diagram No. 1) has offered a uniform incentive to



PIECE WORK DIAGRAMS.

increased effort, represented by the angle of the straight line (C O) to the horizontal. This system not only offers an incentive to effort for increased speed of production beyond the old "day-work" speed represented by the line (A X), but also imposes a penalty should the speed of production fall below it (the diagram cuts the vertical (A X) below the point (A)).

In this system the worker must reach a speed of production between the old "day-work" speed and the new "piece-work" speed before he will make even his old "day-rate" wages, this new speed being indicated by the value of (X) at which the diagram crosses the horizontal line through (A).

In "Piece Rate" (Diagram No. 2) the "immediate" incentive to effort is small, until an established high speed of production has been reached, at which time the "immediate" incentive becomes extreme (infinite rate of increase), (a vertical line on diagram), which means that a saving of a few minutes in his time on the job, when nearing the limit set, (either by great effort or by stealing a little time from another contract), may increase the worker's pay for that job perhaps several dollars, with perhaps some risk to quality of product or of damage to equipment. This is therefore an intensified "piece-work" system.

The penalty for failing to reach the limit (DX) and the reward for passing it are both very great, and it discourages very slow workers, but urges fast workers to very great efforts, provided the selected speed of production (DX) is correctly set at very near the ultimate capacity of the worker and tool. After passing this established speed, the diagram becomes identical with "piece-work," and the incentive the same (in the simplest form of the system).

In the "Premium" system (Diagram No. 3) there is no "immediate" incentive (horizontal line on diagram) until the worker has reached the old "day-work" limit (a low limit) of speed of production. As long as he refuses to pass that limit, either through discouragement, inability or laziness, he is working on "day-pay" and it makes no difference in his pay however little he produces. When he has reached the low limit, however, he has from that time forward an incentive represented by the angle of the line (AO) with the horizontal, which angle depends upon the premium factor allowed him, but which is necessarily less than the angle of the "piece-work" system, as is evident from the diagram.

We will now assume that, through additional skill of the worker, the speed of production has been increased beyond what was at first assumed to be the highest attainable, and that the production, by all three systems, has advanced to the line (F X).

It is now evident that the "wages cost" per piece on the "premium" system is less than on the other two, and this is one of the advantages claimed by the inventor of the "premium" system, that it reduces the "wages cost" per piece in a uniform and progressive manner, with increase of speed of production, and without the necessity of cutting the rates and so discouraging the worker.

If, however, the speed of production for any reason goes back from the original maximum, say to the line (H X), the "wages cost" per piece is least with the "piece-rate" system and greatest with the

"premium system," on account of the differences in the penalties imposed, and shown by the values of (Y), at which each diagram cuts line (H X).

It has thus far been assumed that each of the three systems has, in each case, brought about the same speed of production (and "equipment cost"). This was for the purpose of illustration, and it does not follow that one system may not attain a given speed of production in a much shorter time than another, or that it may not, in a given works, attain a final limit of much higher speed.

This analysis leads to the following conclusions:

The "Piece-work" system occupies a mean position as to the intensity of its action in increasing the speed of production.

It does not (without the cutting of rates) reduce the "wages cost" per piece progressively, but it does rapidly reduce the "equipment cost" per piece, or increase the amount of work produced by a given worker, machine and floor space.

In work of such a nature, or under such a management that the speed of production depends entirely upon increasing skill of the worker, and increases very rapidly with his experience or effort, there may come a time when his rate of wages becomes altogether too high, not only for competition in manufacture, but for good shop discipline.

In other words, the "piece-work" system is applicable where the ultimate capacity of a machine or worker can be determined before hand, by calculation, special observation or by experience, independently of the individual effort, skill or good will of the one worker.

The point (O) can then be determined with a considerable degree of certainty, at or near the maximum limit at which the work can be done with the equipment in use, and if the worker does not know how to reach that speed of production, he must be shown how to do it.

The "Piece-rate" system is an intensified "piece-work" system, in which it is even more necessary that the ultimate capacity of the machine be known at the commencement, as a mistake in the location of the line (O X), where his piece rate is changed, may result in totally discouraging the worker, or in making it a "piece-work" system, according as the limit has been set beyond the attainable, or at a too easily attainable speed of production. The system aims at particularly low "equipment cost" per piece (large output).

The "Premium system" has a less intense action even than the "piece-work" system, and is at the opposite extreme from the "piece-rate" system. The incentive is so slight that it cannot bring about the increased speed of production so quickly, or as great a final speed as

the other systems, nor does it automatically discourage and get rid of incompetent and slow workers, who must be dismissed by the old and most annoying methods.

It does automatically reduce "wages cost" per piece; also, the wages made per hour do not increase so rapidly and need not be cut so soon as in "piece-work," the reason for the last condition being, in part, that the incentive of the "premium" system is less, as shown by the smaller angle, and being a weaker system, it does not build up high rates so rapidly, and reduces loss by forfeit or gain.

If of any value whatever, it is in its application to that kind of work, or under that management in which the individual effort, skill, and good-will of the worker are almost entirely depended upon to show what increased speed of production can be reached. It would be difficult to imagine it applied to operating a screw machine and recording the cost of its product. While it reduces the "wages cost" per piece, it is less active in reducing the "equipment cost," because it offers a less incentive and is milder in its action.

From all the above it appears that the "piece-work" system is smooth and vigorous in its action, subjects the worker to a uniform and moderate incentive or penalty from morning till night and from the beginning to the end of the job, which is usually the safest and most economical method of operating at maximum capacity of tool and worker.

It requires a thorough draughting office system, that the drawings be complete, accurate, and corrected to date, and show all that is to be done on the piece. Also, a highly organized "piece-work" office and a system of estimates, observations, records, and comparisons, resulting in a definite knowledge of what length of time the work should take.

In ordinary works this result can be best obtained by the "subdivided" or "elementary" "piece-work" methods, supplemented by every available form of special observation, estimates on superficial area basis, and the exercise of ingenuity in tabulating estimates and records.

The "Piece-rate" system is one which urges the worker at a racing speed, against a high previously determined standard. It is extreme in its rewards and penalties, and is available only if there be uniformity in the work, and the most exact knowledge of how long each operation should take.

It can not be applied successfully to work which varies greatly through changing and unforeseen conditions, but in the turning of

shafting and the production of other uniform and standard work, there is not the least doubt that it can be made to obtain results more quickly and to a higher ultimate limit of speed of production than even the "piece-work" system. It is evidently unsatisfactory and dangerous in a weakly organized works with an inexperienced "piece-work" staff. It is probably the highest development of the piece-work art.

The "piece-rate" and "piece-work" systems are closely related, the one being a branch or special development of the other. A "piece-rate" ticket can be issued (properly stamped) from any "piece-work" office at any time.

The fundamental requirement of both is the knowledge before hand of what length of time a given operation should take. They both start out by demanding the greatest speed of production of the machine operated by the cheapest possible worker.

The success of these systems depends almost entirely on the thoroughness and accuracy with which the value of operations can be determined, while this in turn depends upon the nature of the work, the organization of the draughting office and "piece-work" office, and upon the methods of dividing the operations into their elements and of recording the results of each ticket, so that the information can be available in various combinations of old elements for new work, for which rates may be required.

Any works operating the "piece-work" system can add the "piece-rate" modification to any of its departments and work the two side by side, because they use the same records and follow the same methods.

The "Premium" system is fundamentally different from "piece-work." It starts upon the basis of "day-work" management and increases the speed of production by offering premiums to the workers to induce them to show at what rate they can produce the work, instead of starting with the demand that the ultimate speed shall be attained.

It is a system of rewards without penalties, which is the basis of its only possible claim to favor with the workers, and is one cause of its weakness.

If the "premium" system has a value it is in work which cannot be analyzed, and whose value can not be previously determined. In other words, to that work which consists of a complicated set of operations which must be handled in the grouping in which they occur, or are dependent upon constantly changing conditions.

In the past this work has been frequently done by the "con-

tract" system, in which a contract price is put upon the job (as, for example, the assembling of a locomotive). This often resulted in the growth of the worker's wages beyond an allowable limit, which under this "premium" system, should be in a measure prevented, but by a reduction of incentive, and therefore a lower final speed of production and higher "equipment cost" per piece.

This reduction of intensity appears to the writer the only good purpose of the premium system, and even that is desirable only where low "wages cost is more important than low "equipment cost."

Even under such conditions, can not better results be obtained more easily by a "reduced piece-work" system, as follows? Place a "piece-work" ticket stamped across its face, "reduced after — cents a definite rate per hour made (fixed for that class of work), the saving in "wages cost" shall be divided between the works and the worker. This would be accomplished in practice by issuing an ordinary "piece-work" ticket stamped across its face, "reduced after — cents per hour."

In extending this ticket previous to its entry upon the "piece-work" records, order distributions, and pay-roll, the mean between "rate limit" and "rate made" would be entered on all records as the "actual rate made" (assuming a 50 per cent. factor).

This gives the same diagram as the "premium system," excepting that a price per piece (see broken line) up to a fixed limit of "rate made," has replaced the "day-pay" in the "premium" system, and this new limit is not dependent upon the individual "day-pay" of any particular worker, and the "rate limit" can be set for an immediate increase of rate of production, in total disregard of old conditions. See diagram (C A O).

While this would accomplish the one practical purpose of the "premium" system, it is without its worst defects, as follows: It removes all complications arising from different and changing "day-rates" among different workers. It abolishes the full "day-rate" pay for a small day's output (behind which a worker can loaf indefinitely under the "premium" system) because it puts a severe penalty on slow production. It prevents a foreman's placing a high-priced worker on work intended for a cheap one, until he has obtained authority to so raise the cost of production.

It overcomes the greatest objection to the "premium system" (and every other mixture of "time-pay" and "piece-pay" in the same day's work) in preventing a worker charging time to "day-work" that has been spent on "piece-work," and thus receiving double pay for that

time and falsifying the records. It removes all the complication of an absurd system of individual day rates, and the continual jealousy and contention, resulting in annoyance to foreman and superintendent and injustice to the workers, due to a system of nominal "day-rates" on work which should be paid for on a basis of amount produced.

Finally, this new proposed system is a modification of the "piece-work" system and can be applied to any ticket at any time, and will work side by side with ordinary "piece-work," and does not introduce unnecessary complication and variable factors, which are inseparable from any combination of "piece-pay" and "time-pay" on the same ticket, and which complications prohibit nearly all of the secondary usefulness which distinguishes the more direct "piece-work" from all indirect systems.

Thus far this discussion has considered the direct effect of the different systems on the rate and cost of production and effect on workers. The secondary advantages of the "piece-work" system and its modifications, most of which are not shared by the "premium" system (or any other, involving a variable factor), are often, of themselves, of the highest value.

For example, in the "piece-work" system the estimated cost of a machine is the actual cost, excepting as modified in perhaps a few of its items, by directions and with the full knowledge of the superintendent. The cost of a machine is known before it is built and only confirmed by the actual returns as they come in.

The definite and certain value on each operation in the construction of a machine becomes as much a part of the data of that machine as are the drawings themselves, and as familiar to the manager and superintendent. The values of these operations form the subject matter of continual discussion among the designers, resulting in cheap and intelligently worked out designs and well informed designers.

The office methods of the "piece-work" system are the simplest and cheapest possible, for the results obtained, because it is the most direct method of using the means available, renders easy and exact the replacing of defective workmanship at the expense of the worker, the valuing of repair parts of machines, the pricing of finished or partly-finished parts of machines in stock, and all the many accounting and cost-keeping processes. This can not be equally true of any system whatever, in which variable factors enter into the cost of operations.

It is a popular error to believe that the modern "elementary"

"piece-work" system is an outgrowth of the old "contract" system, whereas it is absolutely opposed to it in principle and operation.

Much has been said about the relations of men and management in the application of "piece-work." The condemnation of "piece-work" in this connection has, in every case, been founded upon the assumption that "piece-work" prices are necessarily the result of a guess to start with, and continual cutting of rates without the use of tact or common sense. It is not necessary to discuss this in detail, for it is evident that the "piece-work" system is the most direct, easily handled and businesslike method of dealing with workers. It is on the universal principle of all fair dealing, and is of special value in this application, because it is so simple that every worker can understand it. In the "piece-work" system a worker is "in business for himself," a condition developing self-respect and calling out his best efforts.

The "piece-work" office methods and records, in the writer's opinion, should be free to the inspection and enquiry of the workers, should be absolutely without mystery and concealment, and reasons should be given and discussed when asked for. There is a difference of opinion on this last point, and the size of the works and consequent relations between the superintendent and the workers must be a factor in deciding it.

The cost and time required and the difficulty of establishing a modern "piece-work" system in any works depends upon the nature of the product, the general organization and the initial data and experience available. It requires considerable experience and judgment to ensure immediate success. The printed forms, the methods of keeping records and building up data, and all the minor details of the management of a "piece-work" office, are in the aggregate of great importance, and it is a system requiring considerable investment of thought and labor at the outset.

In the writer's opinion, any factory, the nature of whose product will warrant any system whatever, can profitably establish the "piece-work" system and use any of the "piece-work" modifications side by side from the same records, on those branches of the work to which each form seems best suited and side by side with day-work, where necessary, utilizing the "piece-work" form of ticket for subdividing, recording and making special observations on "day-work" orders.

On the basis assumed by the opponents of the "piece-work" systems, namely,—that the rates will be first guessed at and then indiscriminately cut, it is sure to be a failure, and this is not the correct or

modern idea of "piece-work" as a system, which calls for a consideration of human nature as well as tool capacity. Its immediate and its ultimate values to any manufacturing concern depend largely upon the kind of product. Where the work is all special and no two pieces similar, or built up of similar elementary members, the cost of "piece-work" (or any system) may be more than the value returned.

In the manufacture of electrical apparatus it would be almost impossible to compete with modern concerns without it, not only on account of the enormously reduced cost of production secured by it, but also its secondary usefulness in assisting the management. It would be difficult to imagine an indirect or a "day-work" system succeeding in this field, and, in the writer's opinion, it would be an absurdity to expect the "premium" system to succeed in it.

One or two writers have stated, or implied, that but few works are operating the "piece-work" system successfully. Any one acquainted with the machine manufacturing business in its various branches, must know that such a statement is absurd, and that but few successful works in the United States, manufacturing on the duplicate system, are, or can afford to be, without it.

The practical questions in connection with the "premium" system are:

Whether "what is worth doing at all is worth doing well."

Whether the "premium" system in itself is not a make-shift, necessitating greater complication, expense of handling and difficulty of installing, than the "piece-work" system, and very limited in the variety of work to which it can be applied profitably.

Whether every good purpose of the "premium" system can not be better accomplished by the more direct "piece-work" system with tickets modified, if necessary, into "piece-rate" or "reduced piece-work," or such other special forms as may be "invented" for special conditions.

Is not the "premium" system totally lacking in the features necessary for helping, organizing, and rendering automatic the management of a shop, and finally, is it not fundamentally on the wrong principle of mixing variable "time-pay" and fixed "piece-pay" in a complicated, purposeless and ineffective combination, giving a very low "total" incentive and a badly distributed "immediate" incentive in the production of work, and demanding expensive records, of very little secondary value in cost-keeping, designing, and separating good from inferior workers?

Does not the "premium" system demand some knowledge of how

quickly work should be done, and all the office machinery needed to obtain such knowledge?

Starting with that knowledge, however small, will not a "piece-work" system use it and increase it to much better advantage than any less direct system involving "day pay" or variable wages cost of product?

The modern tendency is to specialize the operations of manufacturing, and is towards the use of jigs, fixtures and special machines in the production of interchangeable and duplicate parts, all of which reduce the hand fitting and the time spent in assembling. In the best works the cutting tools are now ground on automatic tool grinders by one workman, while in many works the tool makers are given the supervision of setting jigs and fixtures and the starting of the cheaper grade of workers. The travelling crane has reduced the unforeseen delays and time lost in "waiting." All of these assist the introduction of piece-work, by reducing the variable factors, and they make it more beneficial when established.

In the writer's judgment, the "piece-work" system, with its various modifications, is a manufacturing system good for every class of work which can be systematized at all, and, moreover, its adoption is in accordance with, and progressing in the direction of, modern manufacturing practice. It is on a far broader foundation than the "premium" system, and is a long way from being the "abandoned experiment" that some writers claim. It is the most direct, simple, and, therefore, effective method of building up rapidly and getting the greatest value from a high (or any degree of) organization, wherever such is possible.

From both the manager's and engineer's point of view, it is of value at the start, naturally progressive (a building up process) and of almost unlimited possibilities in lowering the cost of production and increasing the organization, and rendering automatic the operation of a manufacturing works. Where it has failed, it has failed because it has been totally misunderstood and misapplied.

As to the published results attained in various systems, it should be remembered that a new and reduced cost over an old "day-work" cost, is of very little meaning. Almost any system will give better results than a total lack of system, as in "day-work." The improvement shown may mean a good system or a previous very poor "day-work" management.

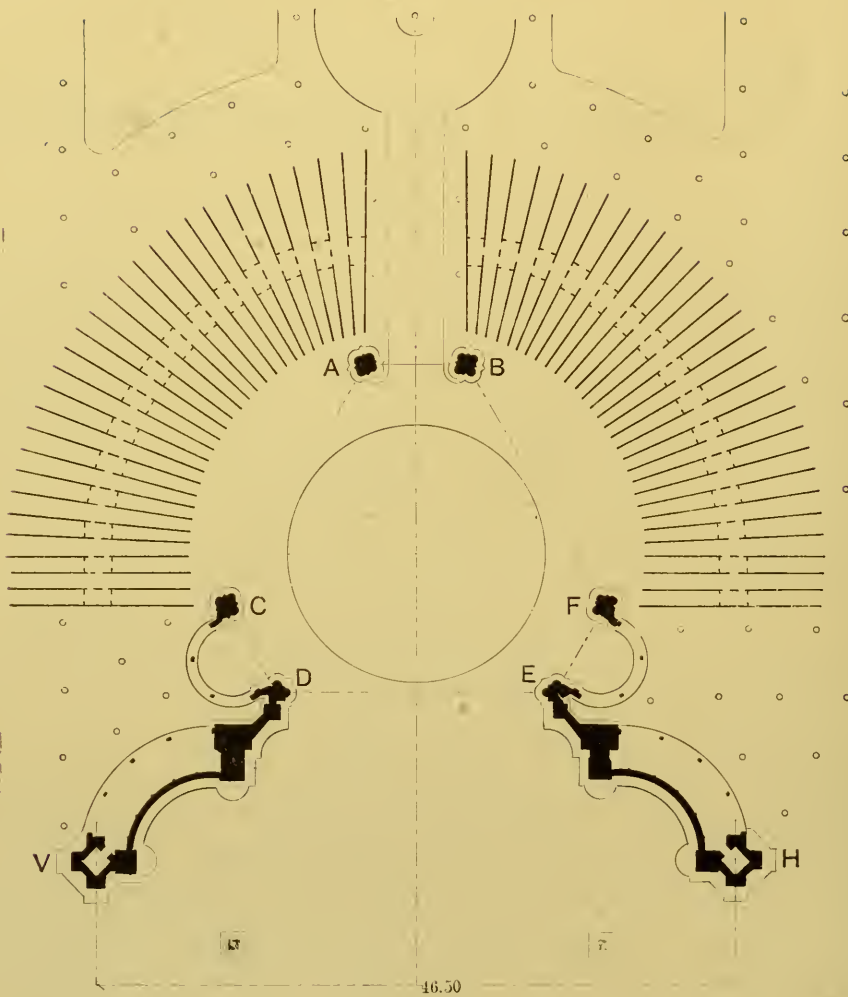
THE BUILDINGS OF THE PARIS EXPOSITION OF 1900.—I.

By Jacques Boyer.

THE conception of industrial expositions is of French origin, and dates back to the close of the last century. It was, in effect, under the initiative of Francois de Neufchateau, Minister of the Interior, that the first exposition was opened on the Champs-de-Mars in Paris, in 1798. A score of square metres then sufficed to house the various manufactured products of the one hundred and ten exhibitors taking part. No foreigners were permitted to exhibit, and the number of awards made by the jury was only 23. From 1801 to 1849, ten similar national exhibitions were held in Paris, but to England is due the merit of extending the scope of the original conception by inviting all nations to participate in the immense competition of 1851.

British and foreign producers to the number of 13,937 accepted the invitation, and the success was enormous. Shortly afterwards, emulating England's example and desiring to do even better, the Emperor Napoleon the Third inaugurated a Universal Exposition on May 15, 1855, in Paris which to the people of that day seemed the *ultima ratio* of its kind. After plans made by Cendrier, the architect of the Lyons Railway Company, a Palace of Industry was built which was also the first large metal framework building constructed on the Continent. Its graceful proportions, the light curves of its arches, the large and beautiful glass windows truly merited all the eulogies bestowed upon them. The area covered by the exposition buildings was 18 hectares, in which 24,000 exhibitors displayed the resources of the arts of peace. Five million visitors arrived from all parts of the globe, and returned fascinated by the result.

The start having been so successfully made, universal expositions followed one upon the other in all parts of the world. It is useless now to recall all the several steps which marked the great advance made in the march of human genius. They are within the memory of all, the last great stride, of the World's Fair at Chicago in point of the area occupied, leaving the Paris Exposition of 1889 far behind. Finally, at the dawn of the 20th century,



PLAN OF MAIN ENTRANCE TO THE EXPOSITION.

France has again deemed it useful to show the commercial, the industrial, the artistic progress of the civilized universe, and though the setting of this enterprise may not be as grandiose as that by Lake Michigan, the celebrated historical monuments of the Louvre, the Invalides, the Tuileries, etc., will frame it exceedingly well, and these associations will, so to speak, bind the memories of the past which they characterise and the aspirations of the future, which the objects exhibited are to enable us to perceive.

Let us therefore from an engineering standpoint go over the works where the many edifices that will temporarily house the rarest products of human activity are beginning to arise. For the purpose of our study, we shall suppose ourselves as started at the Place la Concorde, and shall indicate the prog-



THE MAIN ENTRANCE TO THE EXPOSITION.

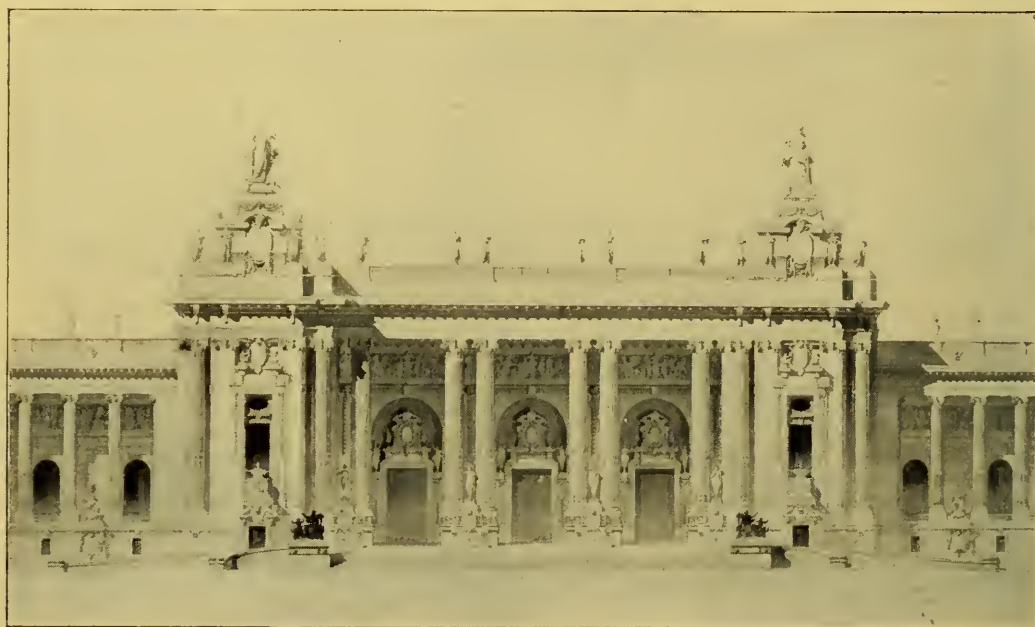
ress and condition of the work during the months of March and April, 1899, introducing the more interesting features and briefly describing the more remarkable structures. Starting at the monumental entrance, we shall pass through the Champs Elysees, Champs de Mars, along the banks of the Seine to the Esplanade des Invalides.

Properly speaking, the exposition of 1889 had no principal entrance, but in 1900 a gigantic entrance will stand on the Place la Concorde at the end of the Quai de la Conference, a place where all the visitors arriving at the various railroad stations will necessarily congregate. This archway will have a height exceeding that of a six story house and the edifice will represent an open-work dome, recalling the Spanish-Arabic style of certain mosques. A principal arch of 18 metres span and 20 metres high will form its facade, the sides again consisting of smaller arches. To correct the rather ungraceful quasi-triangular shape of the structure, the lateral pillars and the pillars arising in the rear of the entrance way will be retrieved by smaller arches.

It is planned for a capacity of not fewer than 60,000 persons per hour through the ticket offices, which are placed in a semi-circle running around the back of the monumental entrance and extending from the left to the right pillar. By an ingenious disposition, adopted

by M. Binet, the architect, they are so contrived that not an inch of space will be lost. Under each ticket office an entrance will be excavated and while one part of the public may enter by ascending, the other by descending an incline will pass under the adjoining ticket office. In this way it was possible to double the number of such offices and to establish 58, instead of 28.

The monumental entrance will be constructed of light masonry and covered with enameled sheet iron. Its front arch is to be amplified by two other larger arches supporting a finial which represents the ship of the arms of the City of Paris, surmounted on its prow by



FAÇADE OF THE FINE ARTS BUILDING.

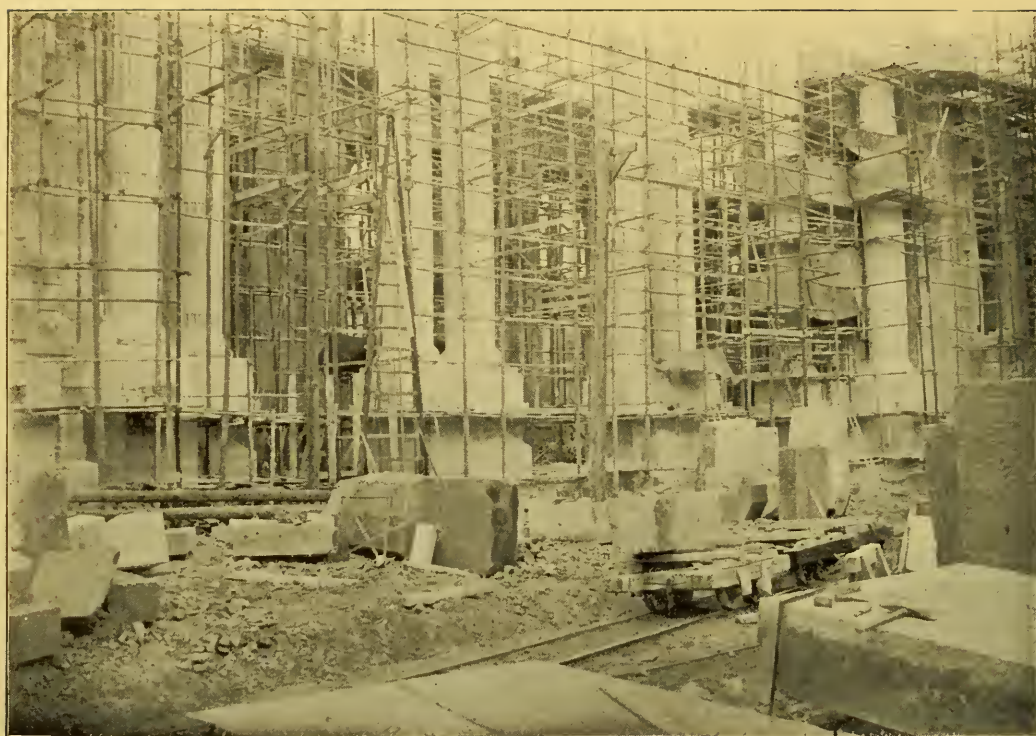
the Gallic Cock. On the summit of the arch, and rising to a height of 42 metres above the ground, a gigantic statue of Peace holding the traditional olive branch will be placed. To avoid the appearance of weakness at the base and facade of the arch, it will there be enlarged by two exedra highly ornamented with bas reliefs two metres in height, by the able hand of M. Guilloit, and illustrating the history of human labor. The top of each ticket office will be decorated with ornamental motives representing the escutcheons of the principal cities of France, and above them again the flags of the divers nations of the universe will float. To the right and left of the main entrance way and adjoining the exedra, two minarets are to be erected, terminating in electric lights. They will stand about 46 metres apart and rise to a height of 44 metres. Sections of colored glass, covering the



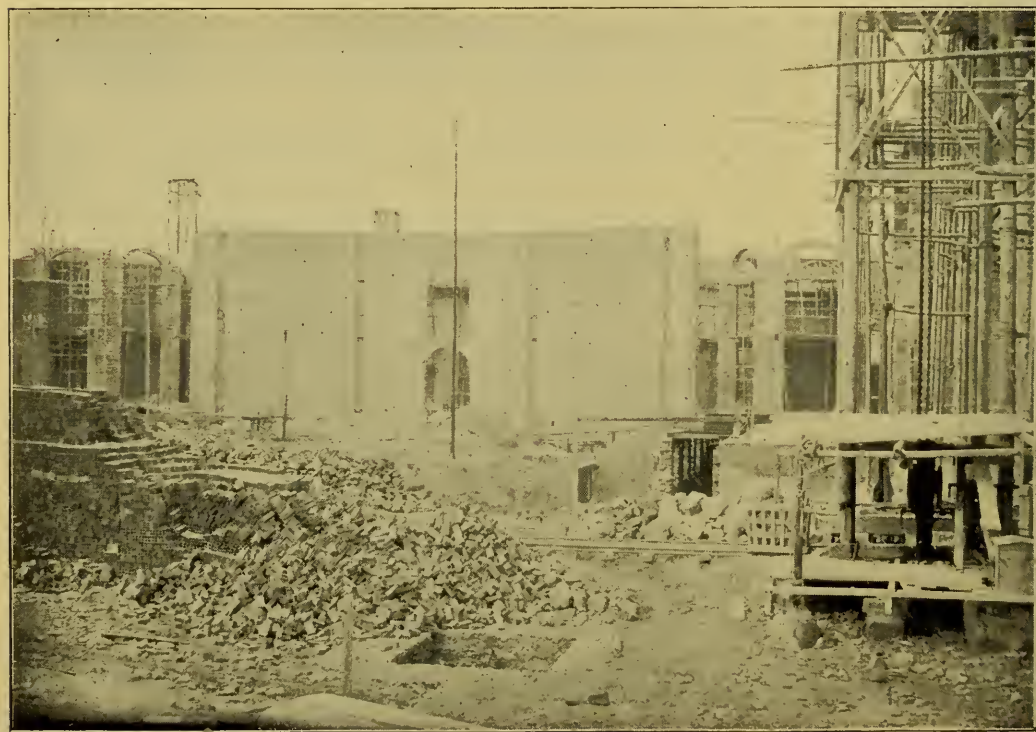
COLONNADE OF FINE ARTS BUILDING.
Showing tall crane tower.

dome, will shine in the sunlight, while at night the incandescent lights enclosed in them will cause them to sparkle in the luminous light rays thrown about from the tops of the minarets. Work on this structure was begun on December 23d last, and is not far advanced. The estimated cost of the grading and masonry work is 80,000 francs, while the metal framework and woodwork will require the additional expenditure of 109,000 francs.

The Fine Art Buildings form the climax of the proposed exposition scheme, and will in round numbers cost 20,000,000 francs, or one-third of the total expenditure. The proceedings had with reference to their construction were extremely interesting. After deciding first to demolish the old Palace of Industry, the Administration opened a competition, with the result, however, that the jury, M. Bouvard, Chief of Services d'Architecture presiding, found that none of the proposed projects could be executed as submitted. A collaboration among the leading competitors was then undertaken. To M. Viglante was confided the interior portion of the grand building facing the Avenue, which on the right bank of the Seine prolongs the Alex-



WORK ON FAÇADE OF FINE ARTS BUILDING.



INTERIOR OF FINE ARTS BUILDING

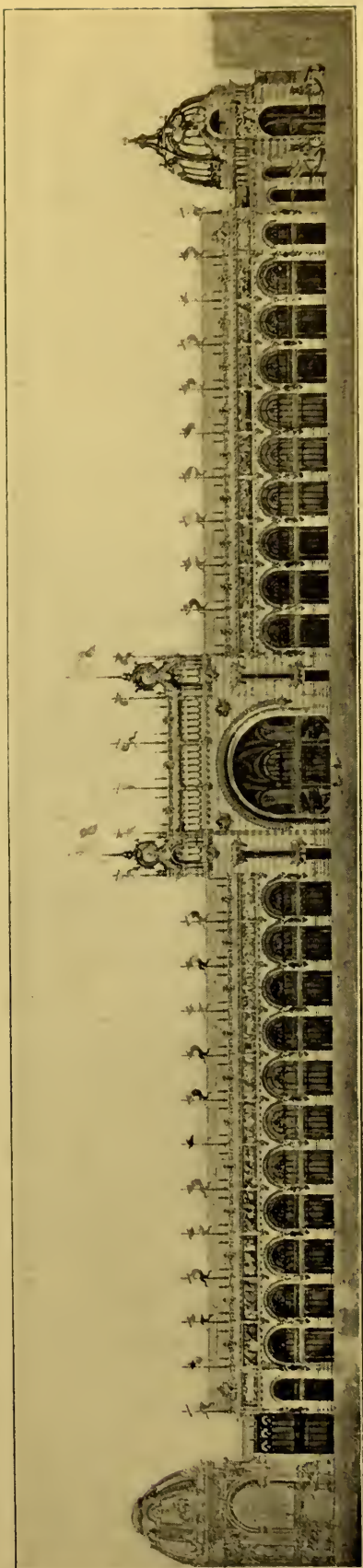


FINE ARTS BUILDING AND STONE CUTTING YARD.

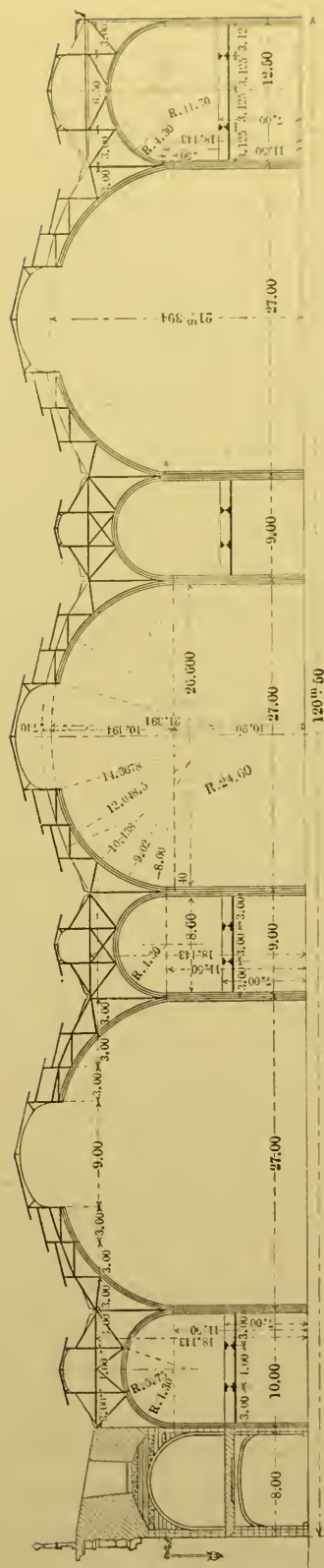
ander III Bridge. The intermediate portion was allotted to M. Louret, and to M. Thomas was given the portion bordering upon the Avenue Dantin. M. Girault, the only artist receiving an award in the two competitions was named architect in chief of the two buildings. A photograph of the final model approved by the Minister of Commerce is shown, and represents the front façade of the grand Fine Arts Building. As can readily be seen, the basement has been considerably lowered so that the proportions of the façade will not overpower those of the smaller building facing it. For similar reasons the peristyle contains but three entrances rather than one of a great height, proportionate to the size of the building. The glass roof is similarly lowered, and in order to avoid unfavorable effect, is masked by the attics of the exterior galleries. These promenades are very effectively arranged and the public will here be able to rest from the fatiguing promenades through the halls of the exposition. The low galleries of the nave will be lighted through the bays at the end of the galleries, while numerous stairways will afford visitors an easy access to the various halls. The curved ends on each side of the large hall will produce an excellent effect, as will also the prolongation of the axis towards the smaller hall. A monumental wrought-iron stairway will here lead the visitors into the adjoining edifice.

The following gives a general idea of the work progressing on this, the most important portion of the Exposition. In March, 1897, the foundations for the work were begun, and 17,000 cubic metres of cut stone, 10,000 cubic metres of ashlar and two million bricks were needed. For the lower courses, which are under the greatest pressure, and which are also subjected to the infiltrations from the soil, a very hard limestone found at Souppes, a village of the arrondissement of Fontainebleau (Seine-et Marne), is being used. The mouldings will be of the finer and softer stone quarried in Lerouville, and which is better adapted to the requirements of sculpture. The ordinary free-stone, requiring no delicate decoration, comes from the quarries at Enville and Villebois. This material is brought in barges on the Seine, to a landing near the Pont des Invalides, where a ten-ton crane erected on a suitable platform, lifts the blocks from the barges and places them on the cars of a narrow gauge railway. The loaded cars pass to the works by a tunnel built under the Quai de la Conference, and the stones are there unloaded on each side of the track by a traveling crane of 12 metres span. When needed, they are placed upon the bed of a diamond saw, and cut to the required dimensions. By the use of this apparatus the blocks are rapidly and cheaply prepared, the cost being only 1.50 francs per metre, as compared with 10 francs per metre for hand work. The cut stones are carted to the place where the work is progressing and there placed in position by means of steam cranes. One of the hoists has remarkable dimensions; it is in the form of an iron tower 40 metres high, the upper part only being movable, and has a lifting capacity of five tons. The mechanical appliances of this plant include a portable engine of 80 horse-power, operating the saws and driving two dynamos. These latter supply the current for the cranes and other hoisting appliances. The accompanying photographs were taken in March and April, 1899, and show the condition of the work on the façade. With exception of the superior entablature, the work was almost finished at that time, and the roof frames were beginning to be placed in April. There is shown also a view of the interior wall of the large hall taken from the side of the Avenue des Champs Elysees.

In order to house the enormous number of exhibits announced, the Administration had to procure as much space as possible for the buildings by reducing the area occupied by the gardens of the Champs-de-Mars. Furthermore, under direction of M. Bouvard, the administration of the exposition drew up a plan and general scheme to which each architect had to conform. Behind the Eiffel tower the



CIVIL ENGINEERING AND TRANSPORTATION BUILDING.



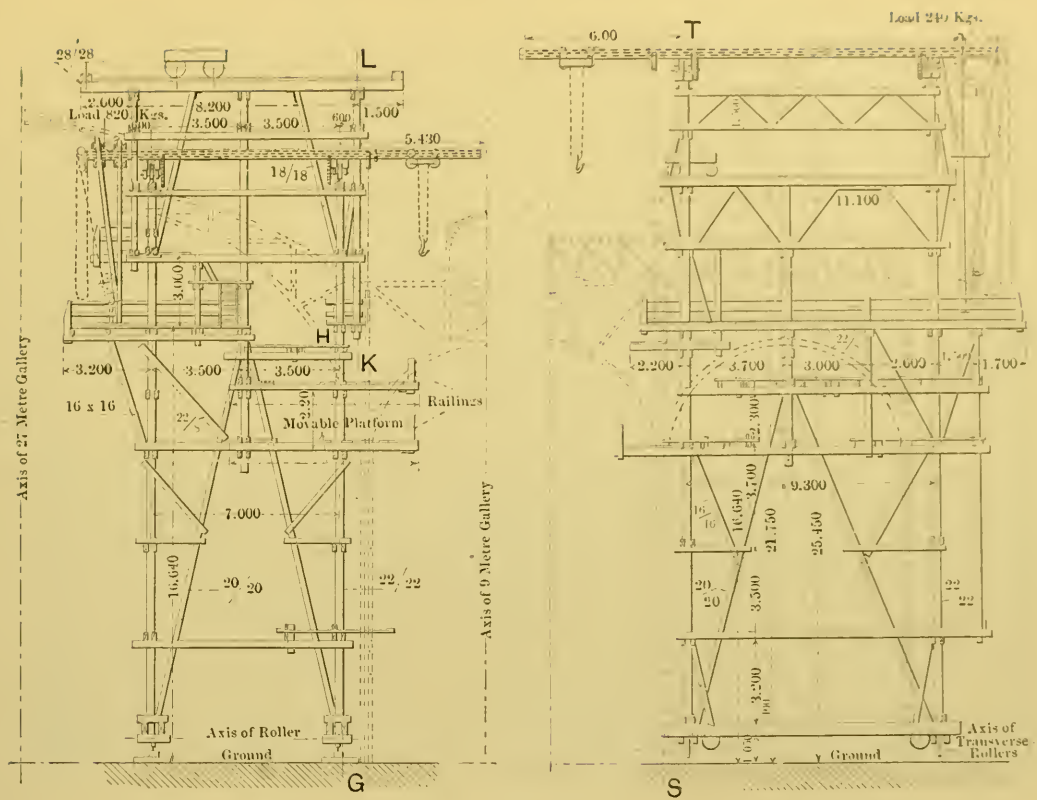
TRANSVERSE SECTION OF CIVIL ENGINEERING AND TRANSPORTATION BUILDING.

edifices were placed in two parallel rows. The Science and Arts Buildings, and those intended for Mining and Metallurgy, are only 16.50 metres high. Each of the following buildings increases in height until a height of 70 metres is reached in the Electricity Building.

It being impossible for us to enter into a detailed description of all the buildings on the Champs de Mars, we shall describe the most interesting and typical one among them, namely, the Civil Engineering and Transportation Building. This is the work of M. Hermant, a very able engineer, who constructed the French section of the Chicago (1893) and Brussels (1897) Expositions. Placed at right angles to the Seine, the Civil Engineering and Transportation Building is 281.40 metres long and 120.50 metres broad. It is enclosed on the river side by the Education Building and on the side of the Machinery Hall by the Chemistry Building. On the remaining side it borders upon the Avenue de Suffren. The framing will for the most part be so formed that curved lines will be used as much as possible. The cross section is the same for all three of the 27 metre galleries, these being supported by two galleries of 9 metres with a nave of 12.50 metres in the rear, and one of 10 metres in front, these last being intended for restaurants. In this manner a sequence of halls will be secured extending from one end to the other of the Champs de Mars, and in addition thereto, a long gallery of 8 metres will run all along the front facade of the Civil Engineering Building. From an artistic point of view this will be the most interesting part of the monument. A light wood framing covered with staff will enable a massive effect to be produced and the upper section will be decorated by a frieze 2.75 metres high, representing in a series of reliefs, by the sculptor Allar, the history of transportation from the primitive cart of our ancestors to the automobiles of the present day.

A monumental entrance opening leads to a vestibule with an opening of 27 metres. This gallery will cross the edifice to the Avenue de Suffren and will form the grand exit. The building will be separated from the Education Building by a transept with an opening of 29.40 metres, ending, as will be seen, in a very pretty cupola of angles covered with transparent materials especially effective for the nightly illumination. At its further end the Civil Engineering Building joins that of the Chemical Industries by a frame of 8.85 metres span ending on the facade by glass panelling of more simple decoration.

The general plans of all the buildings on the Champs de Mars in-

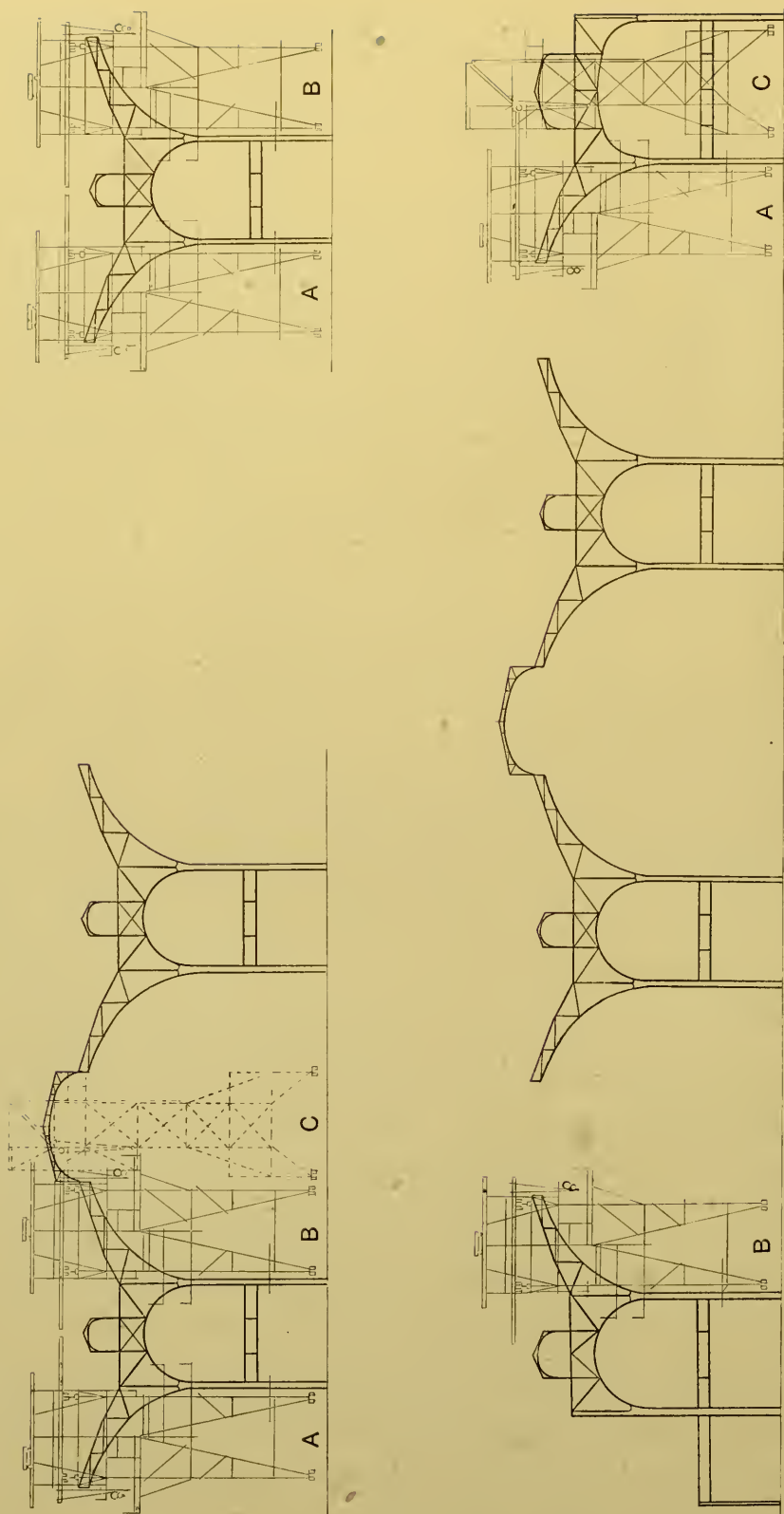


SCAFFOLDS USED FOR ERECTION OF CIVIL ENGINEERING BUILDING.

clude galleries at a height of 7 metres about the ground level, these galleries being placed in all the various naves except the large ones of 27 metres opening, in which the full height is left unbroken. These galleries are connected by bridges at various points, so that an uninterrupted passage is secured.

The characteristic feature of M. Hermant's work is a unique and constantly recurring type of frame, each element of which consists of two cantilever brackets abutting against a central beam, the whole structure resting on two pillars. This middle beam consists of a large truss and the roof of the 9, 10 and 12.50 metre naves. Each bracket is also a truss and together they form the roofs of the large galleries of 27 metres. A clerestory of graceful design covers the 9-metre span between the columns. The successive frames are connected by panels forming an arcade similar in appearance to the corresponding portions of the transverse members.

The erection of the frames was accomplished by means of two movable towers, upon which were placed overhung beams, carrying tracks for trolley-crabs, enabling the opposing cantilevers of the successive frames to be erected without the use of any fixed scaffolding beneath. The two towers were mounted on rollers carried upon rails



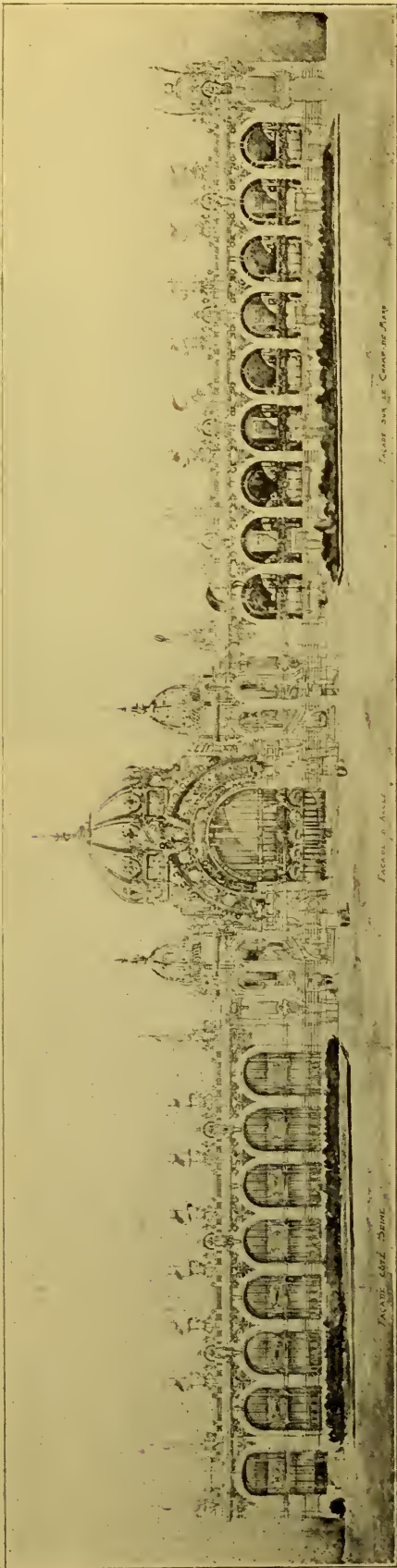
SCHEME OF ERECTION OF CIVIL ENGINEERING BUILDING. A, B, MAIN SCAFFOLDS; C, INTERMEDIATE SCAFFOLD.



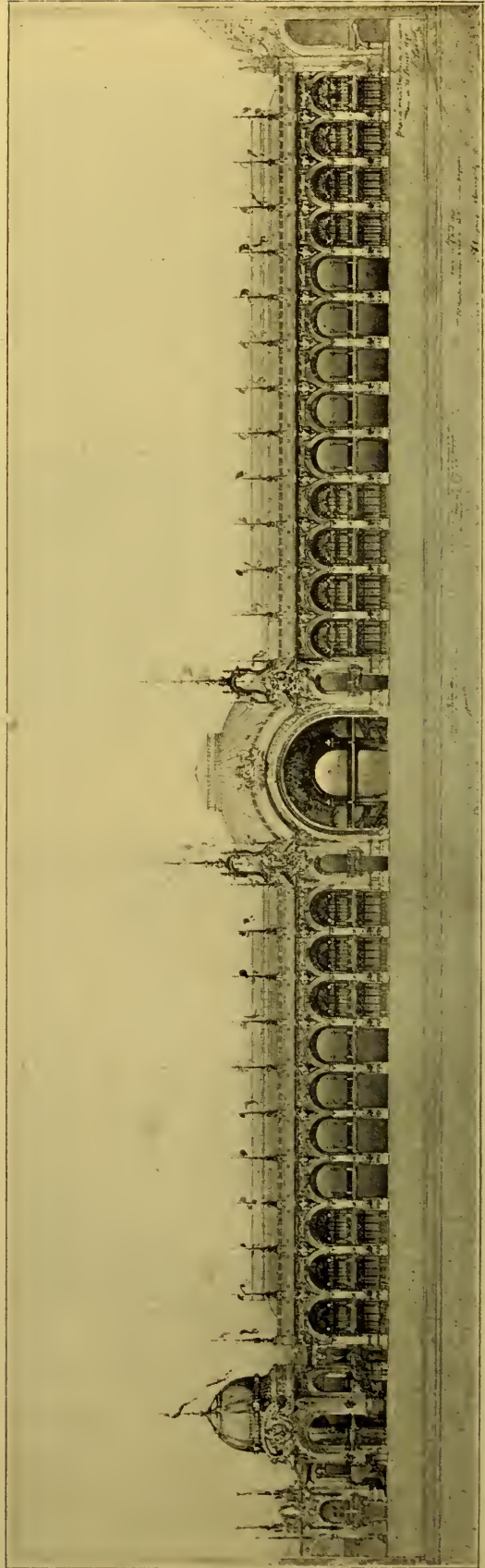
ERECTION OF THE CIVIL ENGINEERING BUILDING.

7 metres apart, and by means of a lever and ratchet gearing they could be moved along the length of the building as each successive frame was completed. The overhung beams upon which the trolleys were carried were at an elevation of 25 metres above the ground, and the rear ends of the beams carried counterbalances of 240 kilogrammes weight. Besides the main hoisting appliances on the tops of the towers, smaller platforms and cranes were used at lower levels independently of the upper work, for the purpose of erection of the lower portions of the frames.

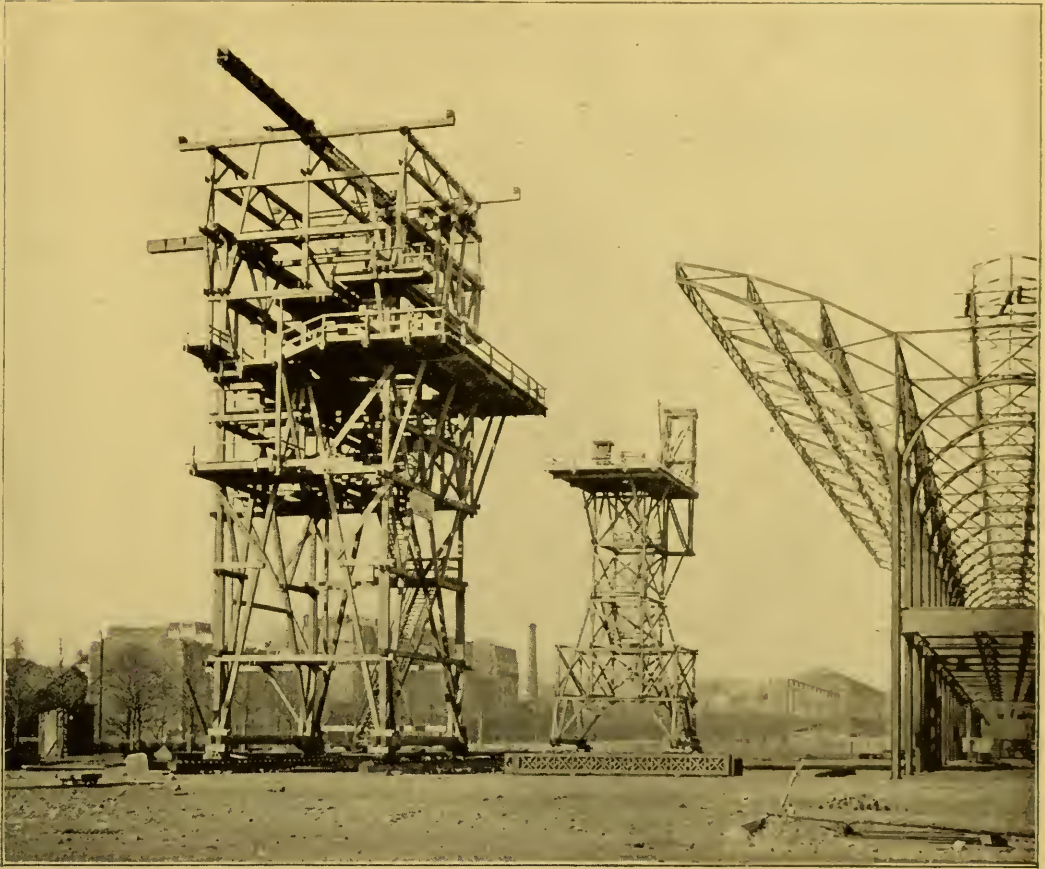
As already stated, the façade of the Education Building will be connected by a rotunda with that of the Civil Engineering Building. Its construction has no distinct features to interest us, and it is progressing rapidly under the direction of its architect, M. Louis Sortais. The Mining and Metallurgy Building on the Avenue de la Bourdonnais, near the Eiffel tower, has its framework completed. The method of erection adopted was different from that employed for assembling the galleries of the Civil Engineering Building, the architect, M. Varcollier, using only a crane to put the members in place. If we may judge from the speed of execution, after comparing and following the respective operations for the



MINING AND METALLURGY BUILDING



BUILDING FOR TEXTILE INDUSTRIES.



THE ERECTING TOWERS OF THE CIVIL ENGINEERING BUILDING.

two buildings, this system, less complicated than the movable scaffolding, appears to us to be the preferable method.

Opposite the Civil Engineering Building we find the building dedicated to the Textile Industries. In length it will equal the Civil Engineering Building and will have a monumental entrance at the intersection of the avenues Rapp and Bourdonnais. The state of this work in March last is shown in our illustration. Two less important buildings are that dedicated to chemistry and that intended for materials of construction, both being built by the same architect, M. Paulin. They are placed to the right and left of the great cascade which is to be at the end of the Champ de Mars. The Electricity Building was described in the March number of *THE ENGINEERING MAGAZINE*. It is placed a little in front of the Machinery Hall of the exposition of 1889. In this corner of the Champ de Mars the work seems less advanced, the foundations have just been completed and in April the assembling of the framework began.

THE INDUSTRIAL SITUATION IN JAPAN.

By Lamar Lyndon.

MUCH has lately been written in various periodicals and trade and technical journals concerning things industrial in Japan, but, as a matter of fact, few, very few, of the articles which have recently appeared have presented actual facts, or correctly described the existing conditions. Travellers and manufacturers' representatives sojourning in the country for a few months by no means obtain a true conception of the character of the people, their business methods, their prejudices, and the conditions and environments that influence their industrial advancement. Even political officials who reside in the country for several years do not accurately grasp the situation, for the reason that they do not come personally in contact with the people whom the manufacturers desire to reach; as a result, consular reports are usually statistics from the customs offices, leavened a bit with general ideas and hearsay evidence.

This article is offered as an outline of the situation as it appears to the writer, whose views are based on an experience in various branches of engineering in Japan extending over nearly three years. At the outset it must be understood that the Japanese are great believers in themselves and their own abilities. Every individual of this race is a living, breathing marvel of self-confidence. There exists no doubt in their minds but that they can accomplish any engineering feat or construction; and repeated failures do not appear to shake their faith in themselves. The reason of this is their lack of experience. Their theoretical education is of a high order and they are generally like the newly graduated engineers who yearly come forth from technical schools, in that they are loaded to the muzzle with mathematics, theories and formulæ in which they put their unqualified faith and they lack the necessary experience to realize how theories and formulæ must be qualified in accordance with varying conditions. They do not have the opportunities of getting the practical knowledge and experience so necessary to successful engineering, and therefore remain theorists. Under the circumstances, they do remarkably well, but never attain to the foremost rank in engineering practice. It must, however, be considered that the industrial age of the Japanese is only about

twenty years, and their position in engineering affairs, though still an inferior one, is extraordinarily high for a race which has so recently entered the field.

One fault which is ever characteristic of the inexperienced is the tendency to purchase cheap machinery and supplies, and this fault is strongly marked in the Japanese. It is difficult to persuade a Japanese to pay more for a good machine than for an inferior one at a lower price, if neither is well known to him. He will, however, pay far more for a machine which he knows and which he has seen operate, even though a better machine be offered at a smaller cost. For this reason it is hard for new comers to dislodge those nations which have long been in the market and have the business already well in hand. If manufacturers wish to build up trade in Japan they must do as others have done—send representatives to the country. These representatives must go with a thorough knowledge of the machinery they propose to offer and be ready to meet any and all questions with both scientific and practical reasons for every detail of design and construction. The next best method to secure Japanese trade is for the manufacturer to place his interests in the hands of one of the good companies engaged in engineering business in Japan.

Labor-saving devices, the first cost of which is high, will not find any market in Japan no matter how desirable such machines might be for other countries where labor is expensive. The interest and depreciation on appliances of this nature will amount to more per annum than the actual cost of the labor they may save. The fact that machinists get about 50 cents per day and laborers only about 15 or 18 cents, should be considered when making up designs for equipments of various kinds, and unnecessary and expensive refinements avoided. In fact, extreme refinements are a positive disadvantage, as the attendance is hardly ever of the best, and is seldom good enough to keep a sensitive or complicated piece of mechanism in proper running order. Therefore a good, plain, simple machine at a low price, the operations of which are assisted by hand, is the best for the Japanese market.

It is true that many of the most extensive and complicated machines are sold to Japanese. These are purchased by the engineers who are theorists, and in the absence of any practice in their own country they follow implicitly the American, English or Continental practice regardless of its fitness, and with but little attention to local conditions. An instance might be cited in the experience of the

writer in contracting with a Japanese company for the sale of some large compound engines. The Japanese engineer of the company insisted upon having vertical engines, not for any mechanical or engineering reason, but because this type was selected by a New York company for the same class of work, and this engineer had seen a description of the New York plant in an American technical journal, and insisted on modelling his plant after it.

The engines in the New York plant had been specially designed to cover the least possible floor space, as they were installed in a locality where the cost of ground was incredibly high, and, furthermore, the plant was on a plot of ground surrounded by valuable buildings, so that increasing the floor space was impossible, and the problem was to get in as much power per square foot of area as practicable.

In the case of the Japanese plant there was ample room to extend on every side, land was cheap, and there was no earthly reason for the adoption of vertical engines. The writer made some calculations which he laid before the Japanese engineer and these showed that the excess of cost of vertical engines over horizontals for the same duty would be \$11,500. The saving in floor space, allowing for a smaller building, reduced cost of ground, etc., amounted to \$830, making it cheaper by \$10,670 to use horizontal engines. It was useless to reason, however. The precedent set by the New York company was followed, and the vertical engines were installed.

All devices and refinements to reduce coal consumption are desirable. Japanese coal sells at from \$2.50 to \$4 per ton, and it is of a poor grade. In designing steam plants the writer never assumed more than 10,000 B. T. U. per pound of coal and believes that 9,500 is nearer the mark. This coal burns with a long flame, making high or long combustion chambers in boiler settings necessary to secure the greatest efficiency.

The favorite types of boilers in use are the Lancashire and Cornish, which are used almost exclusively. This is, of course, the result of following English practice. Very few American tubular boilers are at work in the country, though their low first cost will make them popular as soon as the Japanese discover that they are practically as satisfactory as the internally-fired types.

With the exception of the engines in the electrical plants—which are nearly all American made—the engines generally in use are English built, slow speed, with Corliss valve-gear, the dash pots being placed horizontally upon the side of the cylinders above the

rocking plate. The steam distribution, clearance, and consequently the economy per I. H. P. of these engines is practically the same as that of American Corliss engines; but the mechanical efficiency is lower and the steam consumption per brake H. P. larger.

In spite of these facts it is next to impossible to sell a steam plant alone. The reason of this is the continuance of the ancient practice of placing one order with a single firm for a complete shop or factory equipment including steam plant, machinery, shafting, pulleys, belting, and all transmissive appliances. Of all the large cotton and woolen mills which have been built in Japan, each was equipped complete by a single manufacturer, and as textile machinery is almost invariably purchased from English makers,—except silk machinery, which generally comes from France,—the steam plants are all composed of English engines, boilers, pumps and accessories.

Boilers are fed by means of vertical fly-wheel pumps, the valves being actuated by an eccentric on the shaft; the ordinary direct-acting type so much used in the United States, not finding favor in the eyes of English engineers, who furnish the plants. Economizers are nearly always installed.

In the last year or two the Japanese have begun to appreciate the advisability of buying each class of machines or appliances forming the component parts of a complete installation, from builders who are specialists in the respective lines. Within a few years we may, therefore, expect to see orders divided, just as they are in the United States, the contracts for boilers, engines, pumps, power transmission, and the various machines being placed with different makers.

In this connection it is well to note that all screw threads cut in Japanese shops are Whitworth standard. This applies to pipe fittings, machine screws, and everything else.

Blessings, silent and far away, but none the less heartfelt, will be invoked upon the head of the American manufacturer who has the foresight to cut Whitworth threads on machines intended for Japan, wherever other parts or connections, made in that country, are to be fitted thereto. Some very annoying experiences have fallen to the lot of the writer, owing to the impossibility to get threads cut in Japan to United States standard. One occasion in erecting a steam plant with piping cut in Yokohama, it was necessary to take off and discard the flanges on the heater, separator and engine, and cast, finish and tap new ones, because those sent on their respective openings were tapped to United States standard.

The universally low grade of machine tools found in Japanese ma-

chine shops immediately attracts the attention of the American engineer. They are built in England or Germany, and are sold at prices that represent low figures for their tools but rather high prices for castings. Castings they are, and hardly anything more. They are finished with about as much accuracy as a pile driver, and will do work any way but properly. Cut gears are seldom seen; all lathe, planer, and drill press gears are cast; lumps and fins are removed with a cold chisel and finished off with a file. A nice job of screw-cutting on a lathe with gears like this is a sheer impossibility. In the United States such tools are not to be found on the market. Even the cheapest tools built in America have gears cut from the solid, and some pretence to accurate workmanship is made. The cost, however, of the cheap English or German tool is below that of the lowest priced American tool of equivalent size, and this accounts for the difficulty of introducing American iron-working machinery into Japan.

Every English lathe in Japan is a gap lathe, and there seems to be some difficulty in doing good work close up to the face plate, after the removable section of the bed has been taken out and put back a number of times, especially if much work has been done swinging in the gap, with the carriage over travelling the edge of the break. The fact that it is next to impossible to get a good job of machine work done in Japan is largely attributable to the inferior tools in use. For this reason also, the Japanese use soft castings, regardless of the fact that, though soft iron is easy to work, it wears rapidly when used for cylinders, valve faces, cross-head shoes and guides, and in like positions. Until this phase of machine-shop practice is radically changed American manufacturers need not fear Japanese competition in any country but Japan, and even there, home products are not considered when a really good article is wanted. Specifications containing the clause "None of the apparatus herein mentioned is to be of Japanese manufacture," are often drawn up by native engineers.

Good machinery, however, is to be found in some of the Government arsenals and the shops of one or two railway companies, and in these work is done that approaches western standards in accuracy and finish. These few good machines are making friends and paving the way for a radical change in the class of tools used in Japan. When that country emerges from the present financial difficulties which have hung over it for nearly two years, there will be many improvements in equipments and methods which have been retarded because of the lack of funds to make the changes.

Japanese engineers seldom specify a machine to be of given dimensions, of a certain type and efficiency, and to perform specified work. They usually hunt through catalogues until they find a picture and accompanying description which meets their ideas of what they need. They then write out a specification which is a verbatim copy of the description in the catalogue, frequently designating the number of the page upon which it is to be found. The maker is, of course, to be the party publishing the catalogue. Much trouble has arisen from this practice, as some of the handsomest and most complete catalogues are published by supply houses in America and England which build nothing whatever, and a machine with any name, other than that of the publisher of the catalogue, cast on it is liable to rejection. Certain European firms—and lest this be hurled back at me from the old world let me say here that my attention was first called to this by an English engineer in Japan—take contracts to supply machines from specified makers. They let the contracts to build these machines to jobbing shops by whom they are built for a trifling sum, and are worth about what they cost. The specified maker's name is cast upon the frames of the machines, and the purchaser, supposing them to be from these makers, accepts and pays for them. This has been a common occurrence in times past. The Japanese, however, are progressing so rapidly in their knowledge of these matters that this practice is becoming more and more difficult and less profitable, and will, no doubt, eventually die out altogether. The Japanese Government now requires with each bill of goods coming from a specified maker, a certificate from the said maker to the effect that he made and furnished the goods purporting to be from him.

Only a year ago a reputable company in England building wood-working machinery received a complaint from Japan concerning one of their machines. The machine in question was poorly made, would not perform its work properly and repairs were continually necessary. Upon investigation, the company whose name was cast in large, boldly-projecting letters upon the frame, discovered it to be an imitation of their standard machine, and during the months that it had been doing poor work this company which was not concerned in its production was getting an unenviable reputation for unsatisfactory work and questionable business methods.

The Japanese themselves have put out many imitations of pencils and small articles of a like nature with the names of English and American makers stamped on them, but so far as the writer knows,

they have never built any machinery with the names of foreign firms placed thereon or purporting to come from a foreign builder; though all the machines built in Japan are copied from similar ones built in Europe or America. The imported machines are dismantled, the various parts measured and patterns made therefrom. These imitations are all, however, confessedly Japanese, and are far from satisfactory in their appearance and operation. I have seen a simple condensing engine operating a paper mill in Osaka, with a condenser pump placed tandem with the cylinder and operated by a tail rod, on which the hand on the vacuum gauge oscillated between the five and eighteen inch indices with every stroke. The variation was due to leaks, and in certain periods of each stroke the hiss of air passing through the stuffing-box and past the piston could be plainly heard above the clatter of the engine, which pounded like a stamp mill. This engine was developing two hundred and fifty horsepower with coal worth the equivalent of \$2.75 per ton and poor coal at that!

The Japanese have gone into the manufacture of high-speed engines and electrical apparatus. Their high-speed engines are not successful and probably will not be for a long time yet. Their electrical machinery seems to do better and give fairly good results in practical operation; but the efficiency is low and consequently the cost of operation high. Large and heavy generators have been attempted in only one instance. They work, but that is all. Their efficiency is not over 77 per cent. on full load, and even this figure is doubtful.

Within the past few years the questions of long-distance power transmission and distribution of power in factories by electricity have been taken up, and a few factory power-plants have been installed.

The first complete electric power distribution plant to be placed in Japan was contracted for by the Japan Car Building Co. of Nagoya. The plans were prepared by the writer and approved by Mr. I. Hattori, chief engineer of the company. The next plant of this character was also designed by the writer for Mr. K. Minami, president of the Hankaku Railway. It is operating the new shops of the Hankaku Railway Co. in a little town near Osaka. The Military Arsenal at Tokyo also has a few motors operating individual machines, though most of the machinery there is driven from line shafting.

ELECTRIC POWER FOR MARINE PROPULSION.

By Charles T. Child.

SINCE the earliest days of the mechanical propulsion of vessels, as distinguished from their propulsion by sails or hand-power, there has been a steady decrease in the weights of their machinery, an equally steady increase in capacity for power-storage, or, what is the same thing, coal-carrying capacity, and hence endurance, and a correspondingly great development of speeds. So far the steam engine is the only considerable factor in the situation, and marine engineering practice has so crystallised into definite rules regarding the power equipment of vessels that, given the tonnage, speed and endurance desired, and the class of service for which it is intended, the motive machinery of a floating craft of whatever sort is almost definitely specified.

The rapidity with which electrical power applications have been developed is amazing. In view of their present proportions it seems almost impossible that electric power was a curiosity of the laboratory twenty years ago. But the very suddenness of this development has made it incomplete. Progressing along two main lines,—application of electric power to stationary machinery and to railways,—certain minor possibilities have been neglected. It is to one of these, in connection with the propulsion of vessels, that it is desired to invite attention in this paper.

It may be stated at the outset that electrical motive power is, to-day, only available for certain extremely limited classes of vessels. The floating structure must, of necessity, be self-contained and not, like the familiar electric tram-car, only the translating part of a system comprising a stationary source of power and a conducting structure. It must carry its immediate source of power within itself, except, possibly, in the single case of canal-boats traversing a fixed route under exceptional conditions of operation.

The electrical equipment needed, therefore, for a vessel which does not traverse a fixed path so that it may receive its electrical energy from a generating station, necessarily comprises either storage batteries in some form, or primary batteries, these being the only available sources of electricity not directly dependent upon applied mechanical energy. It is almost useless to review the disadvantages

of the primary battery, even in its most refined and highly developed form. Its great weight in comparison to its available energy, bulk, generally unsatisfactory operation, and absolutely prohibitive cost, exclude it from consideration. It is, then, to the accumulator that the designer of electric vessels must turn for motive power.

The development of the accumulator has been gradual but steady, and, though far from ideal, the present types are fairly reliable and satisfactory structures. Most unfortunately, no certain success has attended any really radical departure from the types of accumulators first employed, the improvements being generally mechanical, whilst the fundamental principle of operation remains the same. No satisfactory substitute for lead and its salts has yet been found, and, these substances being specifically heavy, the weights of accumulators, proportionately to their energy out-put, are still very high. The largest improvement that has been introduced in their construction is through a more complete subdivision of the active materials employed and the general strengthening of the plates, permitting a higher discharge-rate than was formerly possible.

In the essentials of its operation an accumulator is simply a means for storing up potential energy. Electric current acting upon it produces chemical changes in the plates of which it is composed, bringing them to a difference of condition which constitutes them into an electric battery. For a reasonable length of time this condition of unstable equilibrium is maintained, but, upon the closing of an electrical circuit to which the plates are connected, they return to their original condition, giving back as electrical energy a certain proportion of that used in "charging" them, or, rather, in working chemical changes in them.

This return of electrical energy is, necessarily, not so great in amount as that expended in charging the cells. Furthermore, its amount is variable and dependent, among other things, upon the rate at which both the charging and discharging actions take place. This point is one of vast importance in connection with the use of accumulators for the driving of vessels. To illustrate, if a given cell is discharged from full charge at such a rate that the operation lasts ten hours, a certain definite rate of current flow is observed. Now if this rate of flow be doubled, that is, if the cell be called upon to work twice as fast as before, its charge will not last five hours, as might be expected, but only about three, the total energy return being about 60 per cent. of that obtained when the cell is working

at the slower rate of ten hours. Similarly, for a full discharge in one hour the energy is poured out at a rate about four times as great as that accompanying ten hour discharge,—but for only one tenth as long a time. These figures vary widely between various types of cells, those given being probably the fair average for cells built for stationary situations and a fairly definite *régime* of slow charge and discharge. Cells specially constructed for heavy discharge rates shew a better return, but are not so long-lived.

In addition to this troublesome difficulty of the wasteful effect of high discharge-rates, there is an even more serious trouble in the fact that high rates of discharge greatly damage the plates, causing them to bend, or “buckle,” and forcing the active materials (oxides of lead in some form), adhering to the lead plates out of contact with the metal, thus destroying the cells.

Comparing the weights of an equipment of electric motors and accumulators and one of boilers and engines, it will be seen that the advantage of weight lies on the side of the battery. Electric motors, allowing the speeds to be high, can be constructed in fairly large sizes at weights of about 16 pounds to the horse-power of utmost maximum out-put. For the storage battery the weight would depend entirely upon the *régime* of discharge at which it is to be operated. With the best types of light accumulators now constructed for automobile vehicles, the weight has been reduced to from 64 to 75 pounds per horse-power-hour capacity at a five hour rate of discharge. To shew more clearly the interrelation between weight, capacity, output, and discharge the table below, giving data of the batteries of an automobile mail-wagon recently used in London are of interest.

Hours of Discharge	H. P. hours capacity	Discharge rate in h. p.	Lbs. per h. p.	Lbs. per h. p. hour
20	33	1.65	883	44
10	24	2.4	606	61
6	19.2	3.2	455	76
3	14	4.7	309	103
1	8.5	8.5	171	171

Total weight of battery, 1,456 lbs. ; total bulk, 10 cubic feet.

A somewhat better type of cells, also used in electric automobile vehicles, shews 64 pounds per horse-power-hour, and 321 lbs. per horse-power out-put at a 5-hour rate.

Now, assuming the electric motors, circuits, controllers, etc., to weigh 20 pounds per horse-power capacity, the following table of weights, powers, and endurances may at once be constructed, using

the figures given above (for a type of accumulators by no means the best), and assuming an average loss of 20 per cent. in the conversion to mechanical power :

Endurance, in hours.....	20	10	6	3	1
Weight per h. p.....	1124	777	586	406	234
Weight per hp-hour.....	75	58	105	153	234

Steam power plants, adapted for service afloat, weigh from 40 to 70 pounds per horse-power, complete with all auxiliaries except reserve coal, according to their size and design. Coal weighs about 2.5 lbs. per horse-power-hour delivered at the shaft. Hence, taking the average of 55 lbs. per horse-power as a basis, a comparison may be made at once between the steam and electric equipments, the data for the steam corresponding to those given above for electricity being :

Endurance, hours.....	20	10	6	4	1
Weight per h. p.....	105	80	70	62.5	57.5
Weight, per hp-hour.....	5	8	12	20.8	57.5

It might apparently be argued from the foregoing that the electric boat has no *raison d'être* whatever ; but that this is not the case is not difficult to shew by a consideration of certain other elements in the design of a propulsive equipment. In the first place, the figures given, both as regards weights and coal-consumption, for the steam machinery, are not applicable to small boats. In units of small size the weights of engines, boilers, condensers, pumps, etc., are far above 70 lbs. per horse-power, while the coal consumption is greater than that mentioned above,—especially if the engines are frequently stopped and started, or worked below their maximum out-put. These conditions do not in the least interfere with the operation of the accumulator. It has no steam to blow off when the motors are idle, no loss, but rather a gain, in efficiency when it is worked at less than its normal out-put, and, once charged, it is instantly ready for service, requiring neither time nor expense to make it available for full power.

Another feature of the accumulator is that its efficiency is high when it acts to steady a variable load, working near the point of maximum charge as in accumulator installations in electric central stations ashore. Its life is longer under these conditions, and it furnishes a reserve power to tide over any disaster.

If, consequently, there is some craft, now operated by steam, which is worked under variable conditions of use, making many stops, and going often at half speed, it might be well to investigate the opportunities it affords for electric propulsion. An ordinary steam ferry boat, especially one making frequent trips over a short course, as, for ex-

ample, those running between New York and Jersey City, fulfills exactly the specification above. Take the case of such a boat, using compound engines of about 1,500 i. h. p. and making trips averaging $7\frac{1}{2}$ minutes each with stops of equal length between. At full speed engines, boilers, and fires are being worked under economical conditions. About one-fourth of the time such boats, on a crowded river, are at half speed,—a highly inefficient state of things for the motive machinery. Half the total time they are stopped, the fires still burning and everything ready for the next passage.

If a line of these boats should be equipped with electrical propelling machinery and charged from a station ashore as they lay in their slips at the end of each trip, the result would be, if there were boats enough to keep one always in the slip, that the charging station would work on a steady load and could attain the very highest economy of operation. The over-all efficiency of batteries and motors would certainly approach, under the conditions of operation outlined above, eighty per cent., so that power might be actually applied to the shafts of the boats at a coal cost of not more than 2.5 lbs. per h.p.-hour. Adding to this freedom from vibration, prolonging the life of the boat, manœuvring ability of the greatest perfection,—for the pilot could operate the motors himself and thus perfectly coördinate the movements of the boat,—and the entire disposition of the machinery below the main-deck, one reaches a combination of good qualities certainly worth further investigation.

Briefly, the equipment of such a boat would require about 90 tons of battery and 10 tons of motors to replace about 70 to 80 tons of engines, boilers, auxiliaries, and coal. It would cost in the neighborhood of from \$50,000 to \$60,000 as against about \$37,500 for the steam equipment. It would save at least four tons of coal per day, which, at the usual prices, would pay a large interest return on the additional investment in the boat and its share of the charging station.

But the ferry-boat is only one of many opportunities for electrical propulsion. Take the case of a boat requiring high speed, combined with silence and secrecy of movement, and, above all, instant control,—such a craft as a torpedo boat. Here the conditions are entirely different from those obtaining in the ferry boat. Economy is a secondary consideration. Indeed, all other elements of operation must be sacrificed to military efficiency,—in other words, to the fitting of the boat for its service as a sort of directed projectile. These vessels take desperate chances. Once discovered in an attack they are practically certain of destruction. Hence secrecy of movement, silence,

invisibility, and the absence of any elements of construction or operation likely to proclaim the presence of the boat, are all qualities of high value in this class of vessel. All these and more the electric boat possesses. Compare, for example, a steam driven torpedo boat with one of the same tonnage and speed operated by electricity. The electric boat is less visible, because it has no smoke pipes, no smoke issues from it, and, all its machinery being below water-line, its free-board may be made as small as safe navigation allows. It is less vulnerable than the steamboat, because its motive equipment is water-shielded and also by no means so delicate as that of the present type of torpedo boat. On account of the small size of the individual pieces of its machinery it can be minutely subdivided into compartments, thus lessening the danger of sinking from a well-directed shot. Having no funnels to flame under the forced draught employed at high speed, it cannot betray itself in an attack, and its machinery makes far less noise than the flying engines and humming fans of the steam-propelled boat. With all these advantages it has one other, even greater, which is its perfect docility of control. The officer in charge can be steersman and engineer at once, for the control of both directing and propelling machinery may be brought under his hands in small space. And last, and in some ways greatest, is the fact that such a boat would require a smaller crew than the present type, thus reducing the risk of life in an attack with it.

But, unfortunately, the electric torpedo boat has one very serious disadvantage,—small radius of action. Such a boat can be built to-day, using accumulators of the best present type, and about the size of the smallest sea-going steam torpedo boats, capable of a rush speed of 22 knots or over, with an endurance of only one hour at this speed, while the same battery would give a speed of about 12 knots for 24 hours, or a slow-speed cruising radius of 288 nautical miles.

The electric launch has become as familiar as the automobile. In all varieties of small pleasure craft the cleanliness, compactness, ease of operation, and silence of the electric equipment have earned it a highly respected place. In the few submarine boats that have descended (and come up again) electricity has been successfully used as a motive power. On streams like the Rhine, where one end of the ordinary passenger steamboat course is marked by water-power, furnishing locally a low-priced source of energy, the advantages of electric propulsion might be worth investigation.

EDITORIAL COMMENT

WHILE a review of the various articles in the technical press does not always show startling changes from month to month, it is sometimes a very instructive record of the trend and growth of engineering thought and activity. For this purpose a glance over the columns of the Engineering Index is most serviceable, and although it may be open to the objection made by the individual who attempted to read the dictionary, i. e., that the stories are too short to be very interesting, yet after all the discovery of a single item upon one's chosen subject will frequently repay the brief labor of scanning the concentrated expression of the reading and analysis of the technical literature of the month.

It has already been observed in these columns that the work of the various departments of engineering is gradually outgrowing the distinct limitation it formerly set upon it. This is especially true of the work of the mechanical engineer, and it must naturally be so when it is considered how general the application of mechanical devices to all kinds of work is becoming. The great undertakings of the civil engineer are now performed, not by the aid of men with spades, or animals with carts, but by the infinitely more efficient and expeditious excavators, cableways, dredges, and the like. The architect finds himself more and more obliged to limit his work to the æsthetic side of his practice, broadly designing and planning the proportions and decorative features, but of necessity turning to the mechanical engineer to design and construct the framework, plan the equipment, and supervise the erection of the great structures which form so large a proportion of his work.

The same is true of mining and metallurgy, and of electricity, and it is evident that this broadening scope is destined to obliterate to a great extent the artificial boundaries which formerly were supposed to exist, and to merge all branches of engineering into one great profession, having, it is true, specialists in every line but

forming a whole unit when considered broadly.

* * *

There is a general and active interest in the study of the materials of construction, both in mechanical and civil engineering work, and the rapid development of the new science of metallography is already yielding valuable results. With the advanced knowledge of the physical constitution of materials progress is also being made in the methods of computation, and empirical rules and formulas are being superseded by rational expressions, based upon the real actions which take place upon the application of stresses and the production of strains. The extending use of concrete and cement in connection with metallic reinforcement is causing further study of the nature and strength of concrete upon the same lines as have already been applied to metals, and it is beginning to be realized that such materials as stone and concrete obey the same laws of elasticity as do the metals, and that data concerning the elastic limits are as important in the one case as in the other.

Among the papers devoted to electricity are found some of much interest. Attention is being turned to the possibility of producing an electrical accumulator which may be free from the objectional bulk and weight inherent in the lead-plate type. It appears as if the classical laboratory apparatus devised by Professor Grove, many years ago, may develop into a commercial and practical apparatus, and the gas storage battery may yet replace the lead plate. By using other gases than the constituents of water, and by working the apparatus under high pressure, it appears possible to obtain results which may become of much value.

* * *

The interest in space telegraphy continues unabated, and since the successful transmission of messages across the channel, the Marconi system has become the feature of the day. The excellent results obtained by

Professor Ducretet in France, and the possibility of limiting the direction of the transmission to any desired quarter all point to the fact that what has been hitherto only a laboratory experiment, is in the immediate future to become a commercial enterprise.

Another feature of several articles of the month is the increasing attention which is being given to the use of polyphase currents in power transmission. Apart from the advantages and economy which result in the actual transmission, the satisfaction given by polyphase motors renders them applicable for many purposes. Especially is this true for mining purposes, and the possession of a motor without the objectionable commutator, free from all danger of igniting mine gases by sparking removes the one great objection formerly existing against the electrical transmission of power in collieries.

* * *

Electric traction, which has attained such dimensions in the United States, has also progressed rapidly on the continent, and the interest which is now being shown in the subject in England demonstrates that she too will soon possess her share of electric tramways. The obstructions of adverse legislation must rapidly give way before the pressure of public opinion, and the demand for convenient, cheap, and rapid local transport will be fully and completely met.

* * *

The publication of certain untenable claims for liquid air as a source of motive power, briefly noted here last month, has been the occasion of a flood of papers upon the subject in journals of every kind and degree, and it is an excellent sign of the wide distribution of sound knowledge of fundamental principles, that any statement radically opposed to the ultimate laws of matter and energy is so promptly seized and met by readers at large. Liquefied air will undoubtedly have its uses, as was clearly pointed out by Professor Thomson in *THE ENGINEERING MAGAZINE* last month, but it will be for purposes of storage, of refrigeration, of reduction in electrical resistance, and the like that it will be found useful and not as an original source of power.

Compressed air, on the contrary, is meeting with a continually widening field of applications, and while it may not possess the

theoretical efficiency in transmission which can be shown for some other forms it possesses many practical advantages which will render it most useful.

* * *

In the strict domain of mechanical engineering many papers of value appear. In all branches of work increased demands upon materials and mediums of mechanical effect are being made. Higher pressures for steam, air and gas, are the rule, and, in consequence heavier stresses upon the containing vessels follow. Boiler pressures reach 260 pounds, where a few years ago 100 pounds was thought high, while high temperatures and high speeds are too common to attract attention. The strength, or rather weakness, of certain forms of construction, such as pipes, fittings, joints, and the like, has been severely tested under such conditions, and in many cases the real action of combined pressure and temperature has not been fully appreciated until emphasised by disaster. Two notable papers of the month, one in Germany, and one in America, call attention to the necessity of revising the proportions of flange joints to meet the increased stresses, and the paper of Professor Bach, especially shows the extent to which fittings and connections often yield beyond the elastic limit where they have been assumed to be of ample strength.

* * *

The development of the gas engine has been a frequent subject of comment in these columns, and the awakening commercial interest which has developed in the same direction is evidence that the advantages and economy of the internal combustion engine are being appreciated. Improvements in construction, regulation, and above all in the use of cheap forms of gaseous fuel, all these are uniting to emphasise the fact that in very many instances it is far better to burn the fuel in the cylinder where the work is done than under a boiler to generate steam. The most direct method is not always the best, but this is a case where in every point directness has been accompanied with gain. The internal combustion motor may not altogether supersede the steam engine in the near future for all purposes, but there is every evidence that before long the small steam engine will have to go, and its place will be

filled either by the gas engine or by the electric motor, or more probably by both.

* * *

In railway engineering there is evidence of increasing attention to the advantages of the compound locomotive. The economy of compounding now appears to be generally admitted, and in many cases where fuel economy is not a matter of supreme importance steam economy is greatly to be desired. Increased steam economy practically means increased boiler capacity, and for the high-speed express train anything which increases steaming power is gladly welcomed. In like manner the heavy freight train on long stretches of level road makes a steady pull upon the boiler which requires all the steaming capacity to meet. It is in such cases that an economy of 15 to 20 per cent. is gladly welcomed, and it is in such service that the compound locomotive, both of the two-cylinder and four-cylinder type are making steady progress.

All through the broad field of engineering the Engineering Index thus makes record of the progress of the month and to follow its notes in the light of what has already been accomplished is to be prepared for what is to come in the many lines along which progress must be expected.

* * *

Britain has so long been the great workshop of the world that the spectacle of some of her own work being placed elsewhere is a startling one. The purchase of American engines has called forth much comment, some of it unduly pessimistic and some needlessly acrimonious. It is unnecessary either to assume that England is hopelessly worsted in the industrial struggle or to cry out that her rivals' goods are "cheap and nasty."

As a matter of fact, it seems that the placing of many of the orders going to foreign firms has been determined by early delivery quite as much as by anything else, and that English makers could not give nearly so prompt a delivery as others, simply because their works were already nearly overwhelmed with business. It would seem that there is small argument for the pessimist in this. But there is, undoubtedly, much reason to study critically the manufacturing system and industrial prac-

tice which has allowed the possibilities of productions to fall below the exigencies of demand. Without being upon the verge of extinction by foreign competitors, the British manufacturer may be failing to realize his opportunities or to avail himself to the full of the capacity of his works.

The facts are to be faced, and while the truth may be unwelcome, blindness to it is worse. Good work is evidently being done in America and Germany, and the rivalry which now takes the surplus of orders may take more, unless English makers avail themselves of every advance of practice, wherever it may originate. The keynote of American production is specialisation and standardisation—both not only compatible with good work, but actually conducive to the best. Their application in engineering works, in the United States and in Germany, is exhibited in detail in Mr. Orcutt's papers now current in *THE ENGINEERING MAGAZINE*—papers which a discriminating contemporary describes as "searching and salutary, even to a disapproving reader," though it attributes them mistakenly to another excellent engineering journal.

That which is "salutary" will not meet with disapproval from the far-sighted engineer. "My country, right or wrong," in the emergency—but "*my country right*" so long as there is opportunity—and may it be long before the end of the present season of opportunity for study, adjustment and advance.

* * *

The struggle of the engineers for recognition in the Royal Navy seems to provoke quite as much bitterness as was exhibited in the similar movement in the United States, where an apparent solution has been found in the "Personnel Bill." It remains then to test in practice the measure which, while something of a compromise, expresses in the main the judgment of broad-minded men seeking the best results to the service.

The traditions of the sea are stubborn and slow-yielding, or the present order would long since have yielded to the inevitable progress of evolution. Time was when the military man was supreme, afloat or ashore, and the seaman was as subordinate as the deck officers (some of them, at

least) would now have the engineer. But with the progress of tactics and the growth of the advantage to be derived from skillful manœuvring, the sailor, who was the soul of the ship, inevitably forged to the fore, not supplanting but absorbing the purely military command.

And now another step has been effected. The "weather gauge" has given place to speed under steam, together with the speed in mobilisation, whose factors were ably summed up by Mr. W. Laird Clowes in *THE ENGINEERING MAGAZINE* for July, 1898, altogether an engineering proposition. From the first conception of her plans to the minutest move of her working in action, the warship depends upon the brain and hand of the engineer. It is inevitable that his position and authority shall be made commensurate with his importance. Whether the solution be found by merging the deck and engine-room officers in one body (as in the United States navy) or by a collateral development of two corps upon equal planes, found it must be, and speedily, as a necessary condition to the realization of the full effectiveness of that sea-power which is pre-eminently important to industrial stability and supremacy.

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About a year ago, the Secretary of the British Fire Prevention Committee applied to *THE ENGINEERING MAGAZINE* for permission to reprint the illustrated article by Chief Bonner, of the New York Fire Department, describing the equipment and organisation of that force.

This paper, which appeared in our issue for February, 1898, was the fruit of especial and unusual effort and expense; but, out of regard for the distinguished membership and useful aims of the Committee, the desired permission was given and the blocks were turned over to the Committee at a fraction of their original cost, the only condition affixed being that full credit should be given to *THE ENGINEERING MAGAZINE* for the original publication.

When the pamphlet appeared, however, the stipulated credit was so effectively concealed in an introduction which few readers, probably, would notice that the editors felt the single prescribed condition had not been satisfied, though they could not believe it had been evaded.

When, therefore, application was again made to the Magazine, in February last, for permission to reprint Mr. H. DeB. Parsons' study of "The Tall Building Under Test of Fire," appearing, with its unique illustrations, in our issue for that month, expression of our former dissatisfaction was made and the new consent granted upon the express stipulation that acknowledgement to the Magazine be made upon the cover, and at the head of the article, by "a plainly printed line 'reprinted from *THE ENGINEERING MAGAZINE*,' " and the amends for the former neglect be made in the introduction.

On April 21st, after our May issue was off the presses, there came to the editorial desk a copy of the Committee's reprint of Mr. Parsons' article, in the usual red cover of the "Publications of the British Fire Prevention Committee."

The cover bears no word of acknowledgement to *THE ENGINEERING MAGAZINE*; an expression of indebtedness, with no reference, however, to the former neglect, is again lost in the introductory note, and the first page bears, in small italic type, the ambiguous line "A Paper Prepared for the Engineering Magazine."

The paper was not only prepared for, and at the original instance of, *THE ENGINEERING MAGAZINE*, but it was fully published therein and the value of the study, for everyone interested in English fire-risks, was pointed out in our editorial columns in January last. The credit for its "timeliness," made much of in the preface to the reprint, is therefore ill-assumed by the Committee; the seeming effort to obscure *THE ENGINEERING MAGAZINE*'s original presentation of the matter is, to say the least, ill-judged and ungraceful.

REVIEW OF THE BRITISH PRESS

Municipal Advantages of Motor Vehicles.

AMONG the various advantages which are likely to follow the general adoption of automobile vehicles, not the least are those which will affect the sanitary condition of great cities. This phase of the subject has already been briefly noted in a previous issue, and some definite data in the same line appear in a paper presented by Mr. E. Shrapnell Smith in the *Journal of the Sanitary Institute*.

There is no doubt that by far the greater portion of the filth which accumulates in city streets is due to the presence of the horse, and the removal of this source of annoyance and disease would alone render the general use of the automobile a great benefit, so far as sanitary considerations are concerned. Not only is the horse a producer of filth but he is also a distributor, since the pounding of hoofs upon even the hardest of highways assists the breezes in distributing the dust to irritate pedestrians, and poison exposed food-stuffs. To-day, owing to the droppings of the horse and the deteriorating influence of its hoofs, an enormous amount of labour and expense is necessary for street-cleaning purposes. Prevention is better than cure, for which reason the sanitary betterment of city streets by the introduction and extended use of motor vehicles should be encouraged.

Apart from the direct improvement in public health which the removal of the horse from crowded city streets would secure, there are important general economies which would be attained. Mr. Smith gives some interesting computations showing the actual operative economy effected by the use of motor dust-carts in the place of horse-drawn carts, and shows a saving per annum of 43 per cent. in London, and 26 per cent. in provincial cities, by the use of motor vans.

Another important advantage, and one which is as yet not fully appreciated, is the economy in road maintenance which would be secured by the use of motor vehicles.

Undoubtedly by far the greater portion of the wear and tear upon pavements comes from the pounding of hoofs, and the effect of rolling contact, especially when the dragging action of hauling is absent, is rather beneficial than otherwise, tending to consolidate and improve the road, rather than to injure it. The universal adoption of wide rubber tyres which must necessarily follow the introduction of automobiles would render injury to the roadbed from vehicles practically impossible, and incidentally do away with most of the noise and distraction accompanying the present vehicles.

The relief which would be given to the greatly congested streets of most large cities is another feature which renders the use of motor vehicles very desirable. Nearly one-half of the space occupied by a horse drawn vehicle upon the streets is required for the animal itself and when the necessary room for safety to passers is included, it is not too much to claim that the available room in congested streets would be doubled by the use of motor vehicles. Apart from the mere room gained, the better control of the automobile is an important feature to be considered, the ease of backing alone rendering manoeuvring in close quarters far simpler than when horses are employed.

Taking all these manifold advantages into account, it will be seen that the motor vehicle has claims to consideration far more important than the mere pleasure or satisfaction of control which at first drew attention to it, and that on the score of health, of economy, of safety, and of increased capacity the use of automobiles of every sort should be encouraged and advocated.

Acting upon the paper of Mr. Smith, the Sanitary Institute expressed the opinion that the introduction and use of efficient motor vehicles would contribute to the general improvement of the sanitary condition of streets and towns, and recommended that this opinion be made known as widely as possible.

Water-Tube Boilers in the Navy.

NOTWITHSTANDING the many discussions which have been had concerning the defects of certain water-tube boilers which have been used in recent large cruisers there seems to be no disposition to return to tubular boilers, and in the description which is given in *The Engineer* of the machinery of one of the latest vessels, the first-class cruiser Spartiate, it is seen that Belleville boilers are adhered to as the form of steam generator.

This whole subject of water-tube boilers for large units is one which will bear careful examination, not from the controversial point of view, but rather with the aim of evolving the very best type practicable for the trying service demanded in vessels of the navy. Water-tube boilers have firmly established themselves for stationary purposes everywhere, and hardly a great power-house is seen in which there are not thousands of horse-power of water-tube boilers giving continuous and satisfactory results, so that there can be no question as to the real merit of this type of steam generator. The problem, therefore, is not that of designing a satisfactory water-tube boiler in itself, but of adapting the principle to the requirements of naval service.

So far as small boilers are concerned, the task has already been well accomplished, and there are several designs of boilers with small tubes and large steaming capacity which have demonstrated their value in torpedo boats, launches, and other situations. When it comes to the construction of large boilers, boilers which shall compare in endurance, reliability, and capacity with the tubular boilers which have rendered such good service in the past, then it is realised that the problem is not yet solved in a wholly satisfactory manner.

For large units and for boilers which are expected to render continuous efficient service, it is generally admitted that large tubes, that is, about four inches in diameter, are most desirable, the small tubes, such as are used in boilers for torpedo boats and destroyers, being hardly suitable for the larger boilers, in regard to capacity, surface, or ease of cleaning. Assuming then, the use of large tubes, the method of connection and of general disposition must be considered, and it is in these points that

the leading boilers in use differ. In the case of the Belleville boiler, which has found extended application both in the French navy and in the merchant marine, the boiler is built up of so-called elements, each element consisting of a zig-zag combination of tubes and return-bends, extending from the lower feed collector up to the steam separating drum at the top. This disposition possesses the advantage of making the elements, and consequently the whole boiler, amply flexible to yield to expansion and contraction stresses, thus permitting rapid getting up of steam without risk of serious injury. At the same time the circulation is what is termed "restricted," and it must be apparent that, when driven to the full capacity, a boiler constructed on this principle must be liable to have the water from the lower tubes carried up with the ascending vesicles of steam. That serious cases of burning and bending of the lower tubes have occurred with this type of boiler proves that the restricted circulation has its disadvantages, and while in many instances the Belleville boiler has done remarkably well, yet there is no doubt that in the point of circulation at least its construction leaves room for improvement.

An unrestricted circulation is generally attempted to be secured by connecting the tubes both at the front and back, either with flat water spaces, or with sets of headers or manifolds, each tube thus delivering its steam into a direct uptake passage, and receiving a free supply of water from the other end. So far as circulation goes this works well, but it confines the tubes rigidly at both ends, and leaves little or no opportunity for expansion, the only relief being the lateral springing which may occur. It is claimed that the rapidity of the circulation maintains all parts at a nearly uniform temperature, but in practice it is a fact that bent lower tubes are not an uncommon occurrence with boilers of this type, and satisfactory results in practice are principally had by the use of short tubes.

Another form, aiming to obtain unrestricted circulation together with entire freedom for expansion, is constructed with tubes connected to headers only at the front end, the rear ends being closed with

caps, and the circulation being maintained by means of internal tubes or partitions. In some respects this type possesses many advantages, and excellent results have been secured with the Niclausse boiler, a good example of this construction. There is, however, an objection to having the tubes so arranged that they cannot be cleaned through from end to end without dismantling the boiler, a feature which should be attained wherever possible.

These three types, then, are the main forms of large-tube boiler now in use, and while none of them possesses all the features which go to make up a thoroughly satisfactory water-tube marine boiler, yet there is little doubt that out of the three types a final form will be evolved which will become the marine steam generator of the future.

Electricity in Mining Operations.

IN considering the numerous applications of electric power transmission its adaptability to mining purposes at first seems most advantageous. That it is well adapted for operating underground machinery is undoubted, but there are many precautions which must be observed, especially in gaseous mines, otherwise difficulties are certain to be encountered.

A paper recently read before the South Staffordshire Institute of Iron and Steel Works Managers by Mr. J. H. Whittaker, and published in the *Colliery Guardian*, discusses many of the practical questions connected with the use of electrical machinery in collieries, with especial reference to the subject of three-phase currents and motors for power transmission, and touches upon numerous points of practical importance.

The earlier mining plants were constructed to be operated with the continuous current, and when properly installed and care exercised to provide a plant sufficiently large to meet the maximum demands of the work, satisfaction has generally been given.

The principal difficulties have been lack of strength to withstand the necessarily rough usage and proper provision against presence of water. By using enclosed water-tight, motors, and the concentric system of wiring, the difficulties due to the

presence of moisture may be overcome, while the matter of strength is one which can best be remedied by the reconstruction of defective apparatus after experience has pointed out the weak parts; electrical machinery not differing in this respect from any other kind of work.

It is with the motors that the greatest difficulties are necessarily experienced. The generator is usually placed in a clean dry room, with an attendant constantly on hand, and the brushes and commutator, are given every attention. The motors, on the contrary, have hard work to do, are subject to great strains, are generally placed in dirty and wet positions, and yet are generally given much less attention. Brushes are allowed to become worn and displaced, sparking follows, and unless prompt attention is given, the commutator is ruined.

Taking these points into account, Mr. Whittaker called attention to the advantages of the three-phase current for mining work, this being comparatively new for mining service in England, although numerous large plants have been installed on the continent, in America, and in South Africa. The chief characteristic of three-phase generators and motors lies in the fact that no brushes or commutators of any description are required, and thus a much higher degree of safety and durability is obtainable than with any other type of machines. By the use of the three-phase system practically all the objections to electric machinery for motive power in mining operations may be overcome. The absence of sparking is especially important in gaseous mines, since it has been fully demonstrated that under certain circumstances ignition and explosion may follow the production of sparks, and it has even been found necessary to enclose continuous current motors in cages of wire gauze to prevent the possibility of ignition of explosive mine-gases.

In addition to the element of safety, the three-phase current possesses marked advantages when there is any material distance between the generator and the motors, and by its use a distant source of power, such as is frequently found in mining regions, can be utilised and the current delivered to a number of mines with but

little loss. Where power has to be transmitted more than a mile, continuous currents are at a disadvantage, owing to the difficulties of maintaining the insulation of the armature windings and commutator at high voltages, and with low voltages the size and cost of the conductor becomes prohibitory.

The efficiency and ease of transmission of three-phase currents offer strong inducements to mining engineers to use them for transmission, and to use rotary transformers, giving out continuous currents at low voltage at the point of distribution for lighting purposes, and there is little doubt that the practice in Great Britain will soon follow that of other countries in this respect.

The Care of Marine Boilers.

DURING the late war between Spain and the United States some criticism was made of the American fleet before Santiago because of the injury which was done to the boilers of certain vessels because of the use of salt water in them, but from a discussion upon the well-worn subject of the steam consumption of marine auxiliaries in a recent issue of *Engineering*, it appears that the practice of supplying the deficiency of water from the sea is not confined to the American navy.

Referring to the failure of tubes in the Belleville boilers on the *Terrible*, *Engineering* says:

"It has never been claimed seriously that salt water can be used constantly, or for any great period of time, in the water-tube boiler of the Belleville type, or, indeed, of any other. The same remark applies to boilers of the cylindrical and all other types, and evaporators and distillers of ample capacity are provided on our vessels for making up the losses of feed water, which necessarily occur during regular work.

On steam trials the nitrate of silver test is applied to the feed water to determine if there is any leakage in the condenser, or any other possible sources of contamination with salt water and the engineer of the ship in command is expected every watch to use his hydrometer for the same purpose, so that the presence of sea water may be detected. There have been cases before

now of the auxiliary feed having been opened up from the sea to make up a shortage—doubtless without the engineer's knowledge; and the wise precaution is now being taken to have no direct connection between feed pump and sea to the boilers, any sea water required being admitted in the engine-room. This precaution will certainly be effective.

"In one of the cruisers of the *Arrogant* type the bursting of three solid-drawn tubes was caused by deposit, probably due to the use of salt water, but these failures involved no damage because the furnace doors were not opened. It may be noted that a failure of this kind is not so much a question of welded against solid-drawn tubes, although the latter are to be preferred, as of avoidance of deposit in the tubes. In the *Terrible* the saline density of the feed was for some reason or other four or five times that of sea water. But even if a tube gives way, there is usually some warning by the partial leakage of steam, and the commendable course is then to shut the stop valve and open the safety valve of that particular boiler; but certainly not to open up the furnace. If such action be taken, experience has shown that there is no danger to life or limb. But, in addition, it must be remembered that disasters due to a similar cause have befallen the cylindrical boiler, and such mishaps would occur with practically any form of boiler, if sea water were used for any lengthy period. Moreover, there is in the case of the cylindrical boiler no such easy means of averting danger, as indicated in connection with water-tube boilers, as owing to the greater volume of water and steam contained in boilers of the former type, the opening of the safety valve has not the same immediate action as it has in the case of water-tube boilers."

All this is very interesting if we assume that the vessel during the experience of yielding tubes and loss of power is on some peaceful cruise, where speed is of no consequence, and a boiler more or less out of service does not much matter. When, however, as was the case of the American fleet before Santiago, a desperate enemy is making a bold dash for escape, and every pound of steam is needed, and even trial speeds must be beaten if possible, it is small consolation to know what may be done to pre-

vent disaster when the commander on the bridge is calling for more speed, and the full emergency capacity should be instantly available. It must not be forgotten that a warship is a fighting machine, and that her machinery of propulsion is as much a part of her fighting equipment as her batteries. It is as much a breach of discipline to permit her boilers to become scaled as to allow her guns to grow foul and rusty, and the presence of salt in the boilers is as reprehensible as that of water in the magazines. Boilers can only be kept clean by allowing nothing but pure water to enter them, and the detection of any form of scale in a marine boiler at any time is evidence of neglect of duty second only to treason.

Machine Tools.

THERE is no subject so important to the mechanic as the tools with which he does his work, and although it is an old saying that the good workman never complains of his tools, yet this is doubtless true because the good workman will not have tools of which complaint can be made. A general discussion of the present status of the machine tool problem is a feature of recent technical publications, and the latest contribution to the subject is a paper by Mr. E. C. Amos before the Society of Engineers, published in *The Mechanical World*.

That there has been a radical change in the general idea of machine-tool construction is now generally admitted. Says Mr. Amos: "One of the most noticeable features of the modern workshop is the largely increased variety of machines used, in many cases merely a modification of the same tool, and yet sufficiently different to secure some distinctly beneficial result. For instance, an ordinary lathe was formerly used for turning, boring, screw-cutting, and with various attachments also for milling, wheel-cutting, chasing, grinding, cutting-off, bolt and stud work, etc. In place of this we now have lathes specially designed for all these different operations, and with results never imagined by our predecessors. For the one machine doing a great variety of work we have substituted many machines, each dealing with one type of article or process, and this applies to most classes of machines. Another distinctive feature is that parts are all made to tem-

plate, so that any part can easily be replaced, the increasing use of automatic machines making this duplication considerably easier."

A fundamental difference between the modern and the old-time tool lies in the fact that in the older machines the accuracy of the work depended very largely upon the workman who tended the machine, and it was his skill which made fine and accurate products possible. In the case of the modern machine the general arrangements are such that when it is once in adjustment, with tools properly set and ground, the duties of the workman are reduced to those of a mere tender, the accuracy of the product depending upon the machine itself and not upon anything the mechanic can do.

The economical use of such automatic machines depends very largely upon the number of duplicate parts which are to be made, and in this respect the general designer should work in fullest harmony with the manufacturer. Automatic machinery first came into successful use in connection with the manufacture of small arms, sewing machines, and more recently, of bicycles, but since the enormous advantage of repetition work has been fully demonstrated, there is every inducement for the designer of any product to unify sizes, and simplify details to the greatest extent possible, in order to permit as great a use of special and automatic tools as the case will permit. It is surprising to see how much can be done in this way, especially if the machine designer will collaborate with the manufacturer, and endeavor to adapt his ideas to the best facilities for their execution, and this branch of machine design is one which offers a wide field for advantageous study.

Speaking of the competition between American and British tools Mr. Amos says:

"Of the lighter classes of tools, hand tools, etc., the American make is undoubtedly superior to our own, and the competition in the larger machines is getting very keen. Then, again, where the American makers gain so much is in their method of manufacture. Their practice is to put in hand at least a dozen machines at the same time, stocking what is not to order, whilst we manufacture, as a rule, to order only. Their system enables

them to use elaborate jigs and templates, which secures accuracy, economy, and rapidity in manufacture, but does not pay in the case of one machine. Having set a tool to mill, plane, or drill a certain piece of work, it is evidently economical to be able to machine, say, a dozen or fifty of the same kind before removing the jigs and resetting the machine for other work.

"These are points which make it possible for Americans to sell a machine at prices approximating to our own, and often of better quality, notwithstanding the fact that they are paying a higher wage rate and have freight and other expenses to add.

"In large works, and especially in limited companies, where stock is put down at a big figure, it is doubtless inconvenient to throw out a number of machines, but many works at the present time would do the same turnover at less expense if they replaced their present plant of old-fashioned tools by half the number of modern machines. Given work to do, a good tool soon pays for itself, and will last longer, besides turning out far superior work to a cheap one, since the defective tool produces defective work, and at the same time demoralises the operator. Too much stress cannot be laid upon the advantages of good, and the disadvantages of bad tools, and it is satisfactory to know that the demand for high-class tools is largely increasing."

The Structural Strength of Ships.

AMONG the papers read at the recent meeting of the Institution of Naval Architects one of the most important was by Mr. J. Bruhn, discussing the structural strength of ships.

Mr. Bruhn began by calling attention to the fact that all attempts to consider a ship as a built-up girder were defective because of the assumption that the structure is continuous. The hull of a ship does not fulfill that requirement, and hence the common theory cannot be strictly correct. Where the larger portions of the structure are continuous the girder theory is practically correct, but in the neighbourhood of discontinuities it cannot give a true indication of the stresses set up in the material.

After discussing in a general way the girder treatment, Mr. Bruhn proceeded to

show the influence of interruptions of continuity, such for example as is caused by the cutting of a gangway door. In such a case the lines of direction of pull and push stress existing upon a continuous structure would be modified, and very complex stresses would be set up in the plating near the door. The mathematical evaluation of these stresses is a very difficult matter, but Mr. Bruhn showed that their general character can be determined, and by constructing the stress lines he showed quite clearly their nature and direction. In a similar manner the weakening effect upon a ship due to the cutting of hatchways was considered, and it was shown that hatchways of even moderate dimensions cause a very marked reduction in strength.

In order to demonstrate the mathematical deductions given by an analysis of the subject Mr. Bruhn used sheets of rubber, possessing a wide limit of elasticity, and when stretched and cut in a manner similar to the deck or sheets under consideration, these showed very clearly the nature of the stresses and the effect upon the material. The sheets of rubber were stretched with a parallel pull on a deal board; they had fine lines drawn upon them $\frac{1}{4}$ inch apart, both parallel and perpendicular to the direction of the pull, forming a complete set of squares, which, when the material was strained, became parallelograms. The elongation of these figures represented the strain and was measured directly by a scale. The shearing strains, as represented by the alterations in the angles of the parallelograms, were measured by a special device magnifying the scale ten times, thereby increasing the accuracy.

In the course of the discussion of the paper it was brought out very clearly that modern requirements have had much to do with the weakening of vessels. Large hatchways are in many cases required in order to permit the stowage of bulky pieces, while the necessities of the installation of the machinery often interfere with the best disposition of structural members. The only way to remedy these weaknesses is to strengthen the structure in such places as will compensate for the weakening effect as far as possible, and to this end an analysis of the stresses, such as Mr. Bruhn has attempted, is most valuable.

Especial emphasis was laid upon the desirability of making hatch openings and other interruptions of continuity, with round corners, instead of the square corners so generally in vogue. The analysis showed the great increase in stress at the sharp angle of any such opening, and this weakening effect may be materially reduced by using round corners, which also lend themselves readily to reinforcement. The advantage of a critical analysis of the stresses is shown in the fact that when their true distribution is shown it is often seen to be possible to strengthen the structure best by the addition of material at altogether a different place than that where the failure occurs. The so-called practical method is to reinforce the point of rupture, while it often occurs that a much more rational distribution of material can be made than that which is indicated by the mere fact of local yielding.

English and American Locomotives.

THE recent placing of orders in America for locomotives for English railways almost bids fair to revive the one-time controversy as to the merits of the respective types of locomotive engines adopted in the two countries, although that question was very thoroughly thrashed out several years ago. The real fact is that each type of engine is the outgrowth of its environment and is naturally best fitted for the work it has to do.

In the United States there are many grades, curves of short radius, rough roads, and all the features which must accompany the railways of a new country; this with all due respect to the magnificent road beds of such standard roads as the Pennsylvania Railroad, the New York Central, and other well-known railways. The result is a locomotive with bogie truck, flexible wheel-base, equalising levers, in short, everything which can be conceived to make the engine adapt itself to irregularities in the track. The necessity for these features is well pointed out in a communication regarding engines for South American railways, in the *Engineer*. Says the writer:

"I have worked both English and American engines. In one way the English engine is far the best; it does not wear out so quickly as the American engine. But

I have almost always had to make alterations, such as giving more play in the axle boxes. It requires more care than the American engine. But the worst thing about it is that it racks the road as compared with the American engine. The last wears out much sooner than the English locomotive, but costs less money, and it is really a matter of no importance whether an engine lasts five or ten years. Let posterity take care of itself."

Just how the American engines will behave on English roads remains to be seen. The fact that they are built of a type which has been evolved from different conditions may have some bearing upon the case. Still it is well-known that the locomotives built by the firms which are now engaged upon the English orders have given a good account of themselves on railways in the United States, which are of a high character, both as regards permanent way and administration renders it possible that excellent machines will be supplied; machines which should do well in any part of the world.

Engineering Methods in England and America.

IN several editorials in *The Engineer* there has been a rather trenchant discussion of the difference between English and American engineering methods, with especial reference to the reasons for the placing of certain important orders in the United States, notably for American locomotives and for the Atbara bridge.

There appears to be little doubt that the preparations of specifications, as at present conducted in England, by engineers entirely out of touch, so to speak, with the manufacturers, has much to do with the difficulty experienced by English manufacturers in competing with Americans who are given greater latitude. As *The Engineer* says:

"The specifications prepared by civil engineers, acting for the colonies, are so severe and so full of special conditions and stipulations, that English and Scotch builders will not touch them at all, if they can help it, and only work without incurring dead loss if the price is very high."

In the United States, on the contrary, the standard designs are those of the loco-

tive builders themselves, and, subject to slight modifications only, the builder is not hampered by details which involve special patterns and peculiar proportions, but is **only** given general results, which he is expected to attain in his own way.

The same is true in connection with bridge design. The original design for the much-discussed Atbara bridge included a precise specification, which was rescinded when it was found that false works were inadmissible, and instead, only the main requirements, i. e., load, span, and conditions of erection were given, and under these the American builders were able to name so much shorter a time than any English firm that the order was of necessity placed in the United States. This followed because, as *The Engineer* says: "Bridge building has been to a large extent standardised in America, makers have not only all the parts in readiness for immediate use, but have at hand all necessary tools and templates for commencing work on any particular type at a moment's notice."

In England, on the contrary, it is largely the custom for every designer to get out proportions which differ from those of other people, and, moreover, to insist upon having them, so that no ironmaster will dare to roll large quantities of sections, which may or may not be required.

Of course this evil of heterogeneity has grown with expanding trade, and the blame cannot be laid heavily on the maker's shoulders. The contracting engineer and designer are quite as much and more to blame. Whilst they continue to specify

sections which do not exist they not only cause delay by necessitating the turning of special rolls for that particular order, but they put the manufacturer in such a position that he is nervous about stocking such great quantities as the American can with safety put into store. That the price must be higher for both reasons, is obvious."

It is not only to locomotive building and bridge construction that these facts apply, but to many other branches of engineering work. Economy in construction combined with excellence of workmanship and promptness of execution comes only with the application of systematic reproduction of standard types. The day is rapidly passing when each engineering work can be a distinct and individual product, and the time is coming when standardisation must be considered as essential. So long as a reputable builder is prepared to guarantee results, it is for him and for his engineers to decide by what means those results shall be obtained. The true place for the skilled engineer is in the works in which his designs are to be executed, and instead of devising details and specifications for individual structures, his energies should be bent toward the evolution of standard types from which any desired combination may be made at short notice and of highest character. It has been said that science is "knowledge reduced to a system," and modern engineering is rapidly becoming to mean "practice reduced to a system," and the systematised practice is certain in the long run to supersede practice without system, however skillful it may be.

REVIEW ^{OF} THE CONTINENTAL PRESS

The Progress of Electro-Metallurgy.

THE increasing extent to which electricity is being applied in metallurgical operations is evident in many directions, and in a general review of the recent advances which have been made, M. P. Chalon, in the *Revue Industrielle des Mines*, gives some useful data.

The utilisation of electricity in metallurgical operations includes two distinct methods, although it is supposed that in some cases they are combined; namely electrolysis and electrothermancy. Electrothermic methods have been in use for a number of years in connection with the production of aluminum, sodium, potassium, etc., and more recently the intense heat of the electric furnace has been employed in making calcium carbide and carborundum, but apart from these applications there has been little progress of late in electrothermic methods.

Electrolytic methods, on the contrary have emerged more and more from the domain of the laboratory and are daily receiving new applications in practice, and while it is too much to say, as some have done, that they will altogether replace the older processes, yet there is no doubt that they are already rendering notable service. Along this line of work many important researches are being made.

The older processes of Becquerel (1835), Clinton (1840), Werdermann (1880), and Blas and Miest (1883-4), aimed at the ideal operation, that of the electrolytic winning of the metal direct from the ore, but the crude methods employed, and the necessity, in the case of the earlier experimenters, of employing current generated by batteries, made the cost prohibitive. With the advent of mechanically generated currents, however, electro-metallurgy took a fresh start, and to-day is an important branch of industry.

After examining the chemical and electrical laws which govern the practical applications of electrolytic methods, the author gives from the computations of M.

Minet, the mechanical equivalents which are theoretically necessary for the electrolytic and electrothermic production of a kilogramme of various metals, and while the reader is referred to the original paper for the complete list, some of the figures may be of interest here. Thus gold, silver and platinum require 0.70 horse-power hours per kilogramme, while for copper, nickel, iron or zinc three to four horse-power hours are needed, these being for electrolytic methods. The reduction of a kilogramme of sodium by the electrothermic process requires twenty-five horse-power hours, and for a kilogramme of aluminum thirty-five horse-power hours are necessary.

The most extensive applications of electrolysis in metallurgy have been in connection with the refining of copper from the impure mattes produced by the smelting furnace, as will be seen by the fact that there are five electrolytic refineries in Germany, four in France, five in England, two in Russia and eleven in the United States. The eleven establishments in the United States produced, during the year 1896, 124,000 tons of electrolytic copper, 14,000,000 ounces of silver and 70,000 ounces of gold. As the process is now employed, the anode consists of the impure copper and the cathode of pure copper, the bath being an acid solution of sulphate of copper. Electrolysis is also employed for the separation of nickel from copper and from gold, silver and platinum. In this case the anodes are the mattes containing the various metals, and the cathodes are sheets of pure copper, the bath being dilute sulphuric acid. The copper goes to the cathodes, the nickel dissolves in the bath, while the gold, silver and platinum are deposited in the form of a mud. The nickel is subsequently separated electrolytically, using insoluble anodes of lead or carbon and cathodes of nickel.

Much attention has been given to the electrolytic production of zinc, since the ordinary methods are still very crude and

expensive. There are many difficulties, however, in connection with the practical commercial applications of electricity to this metal; its solutions are poor conductors, the metal is frequently deposited in a spongy state, and above all, the low market price of zinc renders an electrical process proportionally almost too expensive. The processes of Siemens and Halske and of Hoeffner have both met with some success, but the best results have thus far been obtained by use of the Ashcroft process, in which a solution obtained by treating oxide of zinc with ferric chloride is electrolysed. This process has been used on a large scale at Broken Hill, but it is not yet altogether demonstrated that the commercial economy of any of the processes is satisfactory unless the recovery of more valuable associated metals is included.

Electrolytic processes as applied to gold and silver only appear as secondary methods. In the case of silver, the Moebius process is employed to advantage in separating it when alloyed with gold, while in connection with the Siemens and Halske modification of the cyanide process the electric current has been very successfully used in the Transvaal as a substitute for, and improvement on the method of reducing the gold by means of zinc shavings.

At the present time the various processes of electro-metallurgy may fairly be considered to have passed the experimental stage, and while there are doubtless many improvements to be made, there is every possibility that the electrolytic tank will in very many instances replace altogether the more primitive furnace.

The Functions of the Steam Jacket.

THERE has for a long time been more or less controversy about the utility of steam jacketting as applied to the cylinders of steam engines, and eminent authorities are still divided as to the economy or otherwise effected by its use, each side apparently being able to quote examples of careful tests to sustain its views.

A very careful review of the whole subject of the functions of the steam jacket, by M. Lefer, is given in a recent issue of the *Bulletin de la Société d'Encouragement*

pour l'Industrie Nationale, following the lines of the analysis of Hirn and Hallauer, and showing how many conditions affect the results and why such contradictory views are possible.

After discussing the heat exchanges as they are supposed to take place between the steam and the cylinder walls in the case of an unjacketted cylinder, M. Lefer goes on to consider the case of a cylinder of which the barrel only is jacketted, and one of which both barrel and heads are jacketted with live steam. The initial condensation and subsequent re-evaporation which go on in the unjacketted cylinder are modified by use of the jacket by the presence of a source of heat which adds its action to that of the cylinder walls. The rapid variations of temperature which occur during the admission and cut-off are practically the same in a jacketted as in an unjacketted cylinder, as the rapidity of the changes is such that they penetrate the metal of the walls only to a very slight depth.

The principal action of the jacket takes place during the exhaust. In an unjacketted cylinder there must always be moisture upon the walls at the beginning of the exhaust, and there will consequently be a re-evaporation, abstracting a certain amount of heat which cannot be restored until the beginning of the next stroke. In the case of a jacketted cylinder the action is not the same. During the exhaust period the interior of the cylinder is in communication with the condenser, of which it tends to assume the temperature. In the jacket, on the contrary, there is a supply of live steam, of a relatively higher temperature. There results an energetic transfer of heat from the outer wall of the cylinder, in contact with the jacket steam to the inner wall, and, if there is no moisture upon the inner wall to be evaporated, all the heat thus transferred will go to elevate the temperature of the inner walls. The essential difference, therefore between an unjacketted and a jacketted cylinder lies in the fact that in the latter case the walls are heated during the period in which there is time for the absorption of the heat, while in the former case the walls become cooled in proportion to the duration of the period of exhaust. Since the cylinder is heated

every stroke, it therefore follows that in the one case the heat must be abstracted from the live steam during the period of admission, while on the other it is supplied from the steam in the jacket. The only advantage, according to M. Lefer, in the use of a jacket, then, lies in the fact that it diminishes the initial condensation; this reduction in initial condensation, however, being made at the expense of heat furnished by the steam in the jacket.

The benefit realised by the use of the jacket, therefore, according to M. Lefer, may be summed up as follows:

1. The partial condensation of steam in the cylinder at the beginning of the stroke being to a large extent diminished by a condensation of steam contained in the jacket, the water produced in the latter is returned to the boiler, while in the former case it passes on into the condenser.

2. The water produced by any condensation during the period of admission being wholly re-evaporated during the period of expansion, and the work represented by this is exerted upon the piston.

3. The absence of moisture on the cylinder walls at the beginning of the exhaust period avoids the abstraction of heat from these walls, which would otherwise take place by the evaporation of the moisture.

For these reasons a steam jacket should be used if it is desired that the highest degree of economy is to be attained.

Since the re-evaporation occurs mainly during the period of expansion, and the whole question of initial condensation and re-evaporation depends upon the extreme differences of temperature in the cylinder and the period of time during which the heat exchanges can occur, it will be evident that in engines in which there is a late cut-off, and which exhaust against atmospheric pressure, there will be little or no advantage in the use of a jacket, and this explains why in many cases tests show that its use is unattended with economy. In the case of a multiple expansion engine the use of a jacket upon low-pressure cylinders is frequently a source of loss, since the range of temperature is not sufficiently great to cause a material benefit to be realised, while at the same time the greater radiating surface causes an increased external loss of heat.

M. Lefer gives a number of comparative indicator diagrams in illustrations of the points made by him, and his impartial examination of this much-discussed question is a valuable contribution to the science and practice of steam engineering.

A Study of the Gas Engine.

THE increasing interest which is being given to the industrial applications of gas engines and other internal combustion motors gives added value to the numerous recent scientific discussions and investigations of the subject. The advent of the Diesel motor has attracted attention to the advantages which may be obtained by using increased compression, and the possibilities of employing cheap forms of gaseous fuel have caused the makers of gas engines to study the proportions and arrangements of parts best adapted for the modified conditions.

Among the scientific studies of gas engines an important one is contained in three papers by Prof. E. Meyer, contained in recent issues of the *Zeitschrift des Vereines Deutscher Ingenieure*, and based upon experiments made with a Deutz Otto engine in the mechanical laboratory of the Technical High School at Hanover. In these tests the engine was so arranged that different degrees of compression could be employed, and the mixture of air and gas were varied and the motor operated at different speeds in order that comparative determinations of the influence of these elements might be obtained.

After discussing the calorific value of various fuels, and describing the methods of calorimetry used in testing the fuels employed, Professor Meyer goes on to examine the method of computing the heat balance of the gas engine, deducing the equations by which the distribution of heat may be computed, and showing the method of their application. Broadly speaking, the total heat may be divided into three portions, one of which appears as effective work, one as an increase in temperature of the water in the cylinder jacket, and the third goes out with the exhaust gases.

It is not always easy to determine the exact division of the heat losses, but by careful measurement of the volume and rise in temperature of the jacket water and

by brake measurement of the effective power exerted by the engine, the remainder may safely be assumed to represent that portion which is rejected with the exhaust gases. When, however, it is attempted to so modify the action that a greater portion of the rejected heat may be converted into work it is necessary to understand the principles which control the heat distribution if improvement is to be expected.

Thus, if an attempt is made to diminish the rapidity of circulation of the water in the jacket, or in similar manner to reduce the proportion of heat carried off through the cylinder walls, it will be found that in general, the only effect will be to increase the proportion rejected with the exhaust gases, the thermal efficiency remaining about the same. An examination of the diagram of the cycle of operations which takes place in the cylinder, however, in connection with the thermodynamic analysis, shows that an increased compression of the explosive mixture should result in an increased efficiency, and it was to demonstrate the truth of this point that many of the experiments were made.

The engine used in the experiments was one of the ordinary Otto type, with the exception that the piston rod was made in two parts, one portion sliding within the other. By use of a clamp and set of split bushings it was possible to alter the length of the rod without altering any other conditions, and thus the degree of compression could be varied and corresponding trials made.

A carefully calibrated Prony brake enabled the effective power developed upon the shaft to be measured, and both the gas and the air entering the cylinder were carefully metered. Thermometers reading to 1-10 of a degree C. were placed in the admission and discharge pipes for the jacket water, the volume of cooling water being determined in calibrated tanks. The indicator by which the diagrams were taken from the cylinder was provided with a water-cooled stop-cock, so that diagrams could be taken continuously without excessive heating of the instrument, and the temperature of the exhaust gases was measured by means of a specially constructed pyrometer of the Le Chatelier type.

The results of these very complete trials

are fully tabulated in the paper of Professor Meyer, and to the original memoir the interested reader must be referred. The general advantage of compression, however, will be seen from the following condensed statement of the average results of trials with four different degrees of compression; all being made with a gas of a calorific power of about 4,700 calories.

The consumption of gas per indicated horse-power when the mixture was compressed to 24 per cent. of its original volume, was 533 litres; when compressed to 25.8 per cent., 559 litres; when compressed to 31 per cent., 624 litres, and when the compression was to only 37.5 per cent. of the original volume the gas consumption per horse-power was 738 litres. There was thus an increase in gas consumption of 38 per cent. in the last case as compared with the first.

Professor Meyer's paper is an important and valuable contribution to the rapidly growing literature of internal combustion motors, and it is to be hoped that his experiments will be the cause of further and similar researches elsewhere.

The Development of Metallography.

THE revelations which the science of metallography have made in the domain of the physical structure of metals used in construction have been deemed so important that the German government has provided for a special investigator in this branch of applied science at the Charlottenburg Testing Laboratory. Professor Martens announces that Herr E. Heyn, a former pupil of Professor Ledebur, has been engaged during the past year in a special line of investigations in metallography, or the microscopical study of etched metallic surfaces, the results of which are now given to the engineering world through the medium of the *Mittheilungen aus den Königlichen technischen Versuchsanstalten* in the form of a carefully written memoir, together with a large number of photogravure reproductions of microphotographs.

Researches in metallography are ordinarily made by subjecting the polished surface of the metal to the etching action of dilute acids or of iodine, and by studying

the structure thus revealed under the microscope, the metal being etched only to a very slight depth. Herr Heyn, however, has followed a line of investigation first suggested by Osmond, and by using the so-called method of "deep etching" has obtained results of much value and interest.

In studying the physical character of iron or steel by deep etching the polished surface is treated with ten per cent. nitric acid for a period of several minutes, the result being a development of molecular structure governed by the varying depth to which the surface is penetrated. When such a deeply etched surface is studied under the microscope, especially with the aid of oblique illumination, the presence of the various forms of carbon and carbon compounds can be seen very clearly, an apparently crystalline structure being formed by those portions which resist the action of the acid. The figures which are thus formed are, however, not generally true crystal forms, but at the same time their study leads to an understanding of the character of the material to a degree not otherwise possible. An excellent preliminary to the study of metals by this process is the examination of well-known crystalline materials of other kinds. Thus if a crystal of rock salt be taken and either a natural crystal surface, or an artificially polished section be partially dissolved, a microscopical examination will reveal a number of more or less plane surfaces, often symmetrically disposed and together forming the so-called etched patterns. As the composition of the material is already known in such experimental cases, the relation of the etched pattern to the real crystalline forms can be compared and studied. Much in this connection depends upon the relation of the etched surface to the true crystalline planes, and a few experiments in this direction with known materials will do much to clear up apparent discrepancies which are met in the course of original investigations.

It is impossible to discuss the remarkable results which have been attained by Herr Heyn without reference to the beautiful microphotographs of etched sections which accompany his original memoir, but a general review of the examples submitted with the paper is most convincing evidence of

the important relation which physical structure bears to strength and durability in metals of construction. It is quite possible for a material to yield an apparently satisfactory chemical analysis and yet be structurally very defective, while the crystalline arrangement must have a most important influence upon the questions of wear and endurance.

The whole subject of the strength and value of materials of construction is so intimately bound up with questions of a physical and chemical nature, that metallography forms a common ground upon which chemists, physicists and engineers must meet and exert united efforts, and nowhere is such work being done to better advantage than in the Royal Testing Laboratory at Charlottenburg.

The Storage of Electrical Energy.

THE question of the storage of electricity has received a great impetus by the rapid development of electric driving in all directions, and notwithstanding its many objectionable qualities, the lead plate accumulator, as originated by Planté and improved by Faure and others, has found numerous applications. The great bulk and weight of even the best of existing storage batteries, however, has always been a drawback to their general use, and great as their advantages have proved for equalisation of load in power-house service, it is yet a question of uncertainty as to their permanent value in portable work.

Under these circumstances the revival of the possibilities of the so-called "gas battery" as a rival to the lead plate accumulator is a matter of decided interest both to electricians and mechanics. The original gas battery of Professor Grove was designed to demonstrate the reversibility of the decomposing electrolytic action of the current, as enunciated by Faraday in his famous "researches," and consisted of a series of tubes containing alternately oxygen and hydrogen. Each tube contained a plate of platinum, roughened with a deposit of black platinum powder, and when the tubes were inverted in jars of acidulated water and the alternate platinum plates connected as in a galvanic battery, the reunion of the gases produced a current which af-

forded all the ordinary electrical phenomena.

Grove's gas battery was but a lecture room experiment, but as such it made a most beautiful contribution to the theory of the correlation of forces and conservation of energy, but the feeble current produced seemed to render it improbable that the apparatus would ever prove of commercial utility. Recently, however, the subject has been revived, and from a recent paper in *La Revue Technique* the suggestions of M. de Nansouty are given, from which it appears that a modification of the original demonstration of Grove may enable some very practical results to be obtained. In the Grove battery only oxygen and hydrogen were used, these being in the proportions to form water, and being generally produced by the electrolytic decomposition of water, and the whole apparatus was operated at atmospheric pressure. M. de Nansouty first calls attention to the experiments of MM. Cailletet and Collardeau, in which it was demonstrated that by working the apparatus at high pressures the capacity was greatly increased. By using spongy platinum electrodes, and decomposing acidulated water in a steel vessel capable of resisting a pressure of 1,000 atmospheres, it was found that for every kilogramme weight of platinum, with the gases at a pressure of 580 atmospheres, a capacity of fifty-six ampere hours could be obtained, with a discharge current of 100 amperes per kilogramme. A number of experiments along this line resulted in the conclusion that the capacity increased with the degree of compression to which the decomposed gases were subjected.

The next step in the increase of the capacity of the gas accumulator was found in the employment of other gases than the constituents of water. Thus, for example, the decomposition of hydrogen into its constituent gases by the electric current and the retention of the gases in a closed vessel under high pressure enables electricity to be stored and again returned when the reunion of the constituents is permitted. It has been demonstrated that in the production of hydrochloric acid an electromotive force of 1.37 volts is produced, and by a suitable connection of gas battery cells of this or similar type almost

any desired combination may be obtained.

It is also suggested that this return to the chemical production of electricity may develop another side of the industrial problem by the adaptation of suitable devices to recover, as a sort of by-product, the electrical energy which is now generated and lost in large chemical works, such as the Solvay process, and, by means of the gas accumulator, send out stored electricity for use in all the manifold lines to which it may be applied.

However practicable this last idea may be, there seems to be every indication that in the gas accumulator, working at high pressure, and using such decomposable liquids or liquefied gases as may be found most suitable, there may soon be found the ideal device for the storage of electrical energy, free in great measure from the drawbacks of excessive weight, rapid deterioration, and high cost, which at present appear unavoidable with the lead plate types of storage battery.

The Behaviour of Acetylene Mixtures.

WHEN acetylene was first introduced as an illuminating medium, it was supposed that its most effective field would be as an entire substitute for ordinary illuminating gas, but commercial considerations appear to have prevented its general use in that manner. Compressed or liquefied acetylene has not been used to any extent because of the evident danger which accompanies the gas in those forms, and thus the principal field which remains open, apart from isolated plants and experimental work, appears to be that of enriching other less costly gases. Such mixtures may be of two kinds, the gas with which the acetylene is mixed being either a combustible and illuminating gas itself and the acetylene being added only to increase the illuminating power, or the acetylene may be mixed with an inert gas, useless in itself as an illuminant, and used in this connection only as a means of diluting the more expensive material. The former method has met its widest application in Germany, where mixtures of acetylene and oil gas are extensively used for lighting railway carriages, and the experiments of Dr. Gerdes, which have been reviewed in

these columns, have showed very clearly the extent to which this may be safely and profitably done.

A recent issue of *Comptes Rendus* contains a contribution to the French Academy by MM. Berthelot and Vieille, to whom so much accurate information upon the properties of acetylene is due, discussing at length the question of the explosibility of mixtures of acetylene with inert gases, and an abstract of the views and results of these able experimenters will be of interest and value in connection with the utilisation of acetylene.

It is well-known that acetylene belongs to the class of endothermic compounds, and disengages heat in course of decomposition. It is therefore desirable that it should be mixed with an exothermic substance, since it is the rapid development of heat which renders the decomposition of acetylene so liable to be accompanied with violent explosion, and the presence of a heat absorbing gas can be used to neutralise this effect.

Since it is most desirable for portable lighting that the gaseous mixture should be compressed into suitable containing vessels, it is important that the explosibility under pressure be determined, and numerous experiments were made to that end. Tests were made both with hydrogen and with Paris illuminating gas, these being mixed with acetylene in the proportions of one-fourth, one-third, and one-half acetylene, the mixture being compressed into a suitable tank and ignited by an electrically-heated wire.

As in the case of pure acetylene, it was found that no definite critical pressure exists at which ignition causes explosion, there being rather a zone, more or less extended, of pressures within which the probability of the propagation of ignition varies with extreme rapidity. The determination of the limits of this zone, therefore, becomes a matter of much importance, if acetylene mixtures are to be used with safety. A number of other points were determined by the tests, the original pressures being compared with those attained during the explosions, and temperatures measured or computed as closely as possible.

A general summary of the results is all

that can be given here, and the salient points are as follows:

In all cases the maximum pressure obtained in cases where explosions were produced, was much lower than indicated by computation, even under the highest initial pressure which was used, i. e., at 583 pounds per square inch and with the mixtures containing the greatest proportion of acetylene, while for poorer mixtures, at the lower pressures of 100 to 150 pounds per square inch, the pressure of explosion was proportionally lower. The pressure at which explosion occurs is naturally lower the richer the mixture is in acetylene. With equal volumes of acetylene and hydrogen a pressure of 57 pounds per square inch is sufficient to cause explosion to accompany ignition, while for one-third acetylene and two-thirds hydrogen, a pressure of 100 pounds is required, and with one-fourth acetylene to three-fourths hydrogen the pressure must be increased to about 150 pounds per square inch. For mixtures of acetylene with illuminating gas the dangerous pressures are higher, being about 100 pounds per square inch for equal volumes, about 170 pounds for one-third acetylene, and as high as 550 pounds for one-fourth acetylene to three-fourths illuminating gas. This effect is presumed to be due to the presence of formene in the illuminating gas, its absorbing capacity for heat counteracting the endothermic action of the acetylene. In using such mixtures it must be remembered that the explosibility increases very rapidly as the proportion of acetylene is increased, but within the limits above given there is reason to believe that no danger from explosion exists.

This exhaustive series of trials is but one more of the valuable contributions which MM. Berthelot and Vieille have made to the practical applications of acetylene, and it is to such careful and authoritative researches that applied science owes some of its greatest debts.

Experiments on Steam Connections.

THE increasing pressures which are met in modern steam plants have rendered necessary a review of the accepted proportions of pipe flanges, valve bodies, and similar connecting elements, and an important

study of the effects of pressure upon existing designs of these members has recently been made by Professor C. Bach, and published in the *Zeitschrift des Vereines deutscher Ingenieure*.

While this paper is largely a record of results, and can only be reviewed in the broadest manner, yet it is such an excellent example of the manner in which such subjects can be studied that it is worthy the attention of manufacturers especially who are engaged in the construction of these important members of a steam power plant.

Every mechanic knows that it is one thing to make a flange joint which shall be strong enough to resist breakage and quite another thing to insure that it shall be tight against leakage under all the trying conditions of continuous service. Much of the trouble in connection with leakage lies in the fact that flange connections, whether on pipes or on valve bodies or fittings, are not stiff enough to resist deformation when subjected to high pressures. Realizing this fact, Professor Bach has conducted a series of experiments in which contact points were so arranged that the deformation under pressure of the various important parts could be accurately measured, and thus he obtained data as to the weakness of existing designs, so far as deformation is concerned, which no rupture tests could furnish.

By comparing these deformation tests with the actual strength and elasticity of the material as indicated by trials in the testing machine, the nature and magnitude of the fibre stress in various portions of the tested pieces was obtained, and thus a check upon theoretical computations of resistance was secured.

The tests were made upon wrought iron pipes, and upon valve bodies of cast iron, cast steel, and bronze, and the data thus obtained are tabulated in a manner which renders them available for use in connection with future designs. The whole subject of steam connections should be revised in view of the changed conditions which

modern practice has brought about, and makers of valves and fittings for such service might well conduct some such tests upon their own account in order to be assured of the correctness of the proportions adopted by them.

Ice Breaking Boats in Russia.

THE use of powerful boats for breaking the ice in frozen harbors and thus maintaining a channel open for navigation is well-known in the United States, but the only country in Europe in which such boats are used is Russia.

In a communication to the *Comptes Rendus* of the French Academy M. Venukoff gives some notes about Russian ice boats. In February of the current year a powerful boat of this class was put into service in the harbor of Cronstadt, where much trouble is experienced from the ice. This ice boat is equipped with engines of 12,000 horse-power, and is able to maintain a speed of about two miles an hour through ice five feet thick, or four and a half miles per hour when the ice is only three feet in thickness. There are four screws, of which one is intended to break the ice and the other three are to propel the boat through the broken ice and clear a channel. There is a still more powerful boat of the same type in the harbor of Rével, the engines in this case being of 23,000 horse-power.

In connection with the transportation of trains of the Trans-Siberian Railway across Lake Baikal, it has been found necessary to employ very powerful ice-boats, and there is one in this service with engines of 40,000 horse-power doing good service in connection with the train barges by which, until the connecting line around the lake is completed, the trains are transferred from the western to the eastern section of the railway. There are also some very powerful ice breakers in use at the ports of Odessa, Vladivostock and Kertch, but precise data about these are lacking.

REVIEW ^{OF} _{THE} AMERICAN PRESS

Engineering in Modern Buildings.

AMONG the papers presented at the Washington meeting of the American Society of Mechanical Engineers there are three which indicate to a marked degree the extent to which engineering work enters into modern buildings, especially in the United States. The modern tall business building is a veritable power-house, and the paper of Mr. R. P. Bolton, on the equipment of tall office buildings in New York City, gives an excellent idea of the extent and nature of the mechanical appliances required for these and similar structures. The other two papers referred to are devoted to a different line of work, namely, the power plants of educational institutions; one, by E. A. Darling, being a very full account of the mechanical plant of the new buildings of Columbia University, at New York, and the other, a description, by Professor Storm Bull, of the central heating plant of the University of Wisconsin.

The modern office building has to be warmed, lighted, and provided with vertical transportation in the form of elevators; and to these requirements may be added in some cases mechanical ventilation, so that there are to be found in the basements of these buildings steam plants of 400 to 7 horse-power, electric generators, accumulators, pumps, and a great variety of small machinery, all demanding the skill of a competent engineer in the original design, and the care of several mechanics in daily operation.

Until recently the importance of the engineering features has not been sufficiently considered in the original design of such buildings, and the engineer has been called in to plan the equipment long after the general arrangement of the space has been decided, or even after the building is partly completed. He then finds insufficient space for boilers, piping and transmission, and often inadequate planned and badly placed chimneys, and numerous inconveniences which might have been avoided, all prevent-

ing the most advantageous arrangement and operation of the machinery which has become such an essential part of the work. The fact that the consulting engineer is now being called in at a much earlier stage of the work is a gratifying evidence of the appreciation by both owner and architect of the fact that such buildings are really engineering works. The steel framing, the fire-proof arches, flooring, and lathing, the massive foundations, and nearly all the structural details must pass under the eye of a competent engineer, and last, but not least, the operative machinery, forming so large a portion of the equipment, demands his best attention.

If these facts are true with regard to office buildings, they are even more so in connection with the aggregations of buildings which have grown to form the shelter and housing of great educational institutions. Here there are not only the functions of warming, lighting and ventilation to be fulfilled, but in most cases complete machinery shops, mechanical and physical laboratories, to be operated, and general experimental work to be performed. Added to this we have in most cases a number of detached buildings, all requiring varied service, and many of them situated at a distance from the power-house from which all are to be served.

In the case of the power plant of Columbia University, at New York, which is so fully described by Mr. Darling, the new start made by the removal of the University to another location, and the entire construction of new buildings, gave a scope for original plans and the exercise of engineering discrimination not usually possible. The plant is also of especial interest in that it was worked out by the unique combination of a most capable firm of architects acting in conjunction with the engineer by whom it was afterwards to be superintended and operated, and with the aid of the best consulting experts who could be obtained in the departments of electricity, warming and ventilation. The result is a power plant

of the most complete and comprehensive character, one which is planned for the future, as well as the immediate present, and one which had the great advantage of being conceived as a whole, with all the data clearly marked out in advance. It may be of interest to note that Mr. Darling estimates that the cost of the power plant and its connections, including the entire operative engineering equipment, represents about 10 per cent. of the total investment in the buildings which it is intended to supply.

Professor Bull's paper shows the other side of the subject, and unfortunately the side which the engineer is most frequently called upon to contemplate, i. e., the construction of a plant to meet conditions which already exist, and which are by no means those which he would have advised had he been consulted at the start. It is an excellent study, however, of the manner in which local difficulties may be overcome, and includes some useful data and results of tests.

The presentation of those papers before such a convention is an excellent indication of the broadening scope of the work of the mechanical engineer, including, as it does, the work formerly limited to either the architect or the civil engineer, but now become more and more mechanical in character, methods, and object.

Tests of Steam Coals.

THE question of the thermal value of a coal for steam-making purposes is one of great importance to the mechanical engineer, but until recently the only reliable tests on record were those made many years ago upon a limited number of coals. The recent activity in this line of research is very fully discussed in a paper upon comparative tests of bituminous steam coals, presented before the American Society of Civil Engineers, and published in the *Proceedings* of that Society.

After referring to the papers presented before the American Society of Mechanical Engineers by Carpenter, Barrus, Lord, and others, Mr. Hill proceeds to describe the extensive tests made under his direction for authorities of the city of Cincinnati. These tests included a practical steam trial of each kind and grade of coal, under uni-

form conditions, for a period of sixteen hours; a proximate analysis of each kind of coal; and a calorimetric determination of the heating power of each. The physical tests were made by burning from 18,000 to 25,000 pounds of coal upon the grates of a pair of Galloway boilers, and measuring the evaporation by means of carefully calibrated water-meters.

Fifty-four kinds of coal were tested, of which thirty-three were from West Virginia, fourteen from Pennsylvania, and the balance from Ohio, Kentucky, and Tennessee. The results from these coals, which are grouped by localities, are very fully tabulated in Mr. Hill's paper, and from the tables most valuable data may be obtained for the future in connection with the use of these different varieties.

It is not supposed or claimed that the results indicate the best possibilities with these coals but they do indicate what may be expected in daily practice, with careful firing by the usual force of men such as are employed in the city water department.

The calorimetric determinations of the heating power of the various coals were made with the Carpenter calorimeter, this, after careful investigation, having been found acceptable. The instrument is really a very large thermometer, the fuel being burned in the bulb in the presence of pure oxygen under pressure, all the heat being absorbed by the fuel or lost in radiation. Tests made with foundry coke and with pure carbon, enabled the instrument to be calibrated for losses, and determined its accuracy within permissible limits of error. The proximate analyses gave the proportion of moisture, volatile matter, fixed carbon, and ash, and enabled the calorific power to be computed independently, thus furnishing interesting comparative data.

An interesting portion of Mr. Hill's paper is devoted to the discussion of the heating value of various coals, plotted as a curve, as suggested by Mr. William Kent, using data from Mahler, Lord and Haas, Carpenter, Hale and Williams, and the tests of Mr. Hill above described. Mr. Kent's curve was intended to give a mean of the various tests in such a manner that the calorific value of any coal could be graphically determined by inspection by knowing

the percentage of fixed carbon in the net combustible, but the actual heating power of the coals tested by Mr. Hill was decidedly lower than that which would be assigned to it by the Kent curve. Mr. Hill thinks that this can hardly be explained by errors in his results, but observes that the general application of Kent's curve may be limited by the variable nature of the volatile matter in bituminous coals, these having a material effect on the calorific power and not being included in the data required by Mr. Kent.

It is impossible, in the limited space here available, to do more than indicate briefly the nature of the results obtained by Mr. Hill's tests, and they can only be regarded as comparative with each other so far as the actual evaporative power is concerned. None of the coals gave an evaporative efficiency under the boiler of more than 66 per cent., and the majority of them were below 60 per cent., and although the boiler and furnace were supposed to be in good condition, Mr. Hill admits that some of the coals were worked at a disadvantage. There is no doubt that better results would be obtained for bituminous coal with greater space above the grate than is possible in an internally-fired boiler, such as that in which these coals were tried. Still the completeness of the tests and the fullness of the data accompanying Mr. Hill's paper render the whole a most valuable contribution to the science of steam generation, and the complete record will undoubtedly be freely used hereafter, both for commercial and technical purposes.

The Engineering Profession.

IN the course of an address delivered by Mr. John Sterling Deans, before the students of Lehigh University, and published in the *Engineering Record*, some most excellent remarks are made which bear upon the work of the engineer at large, and are not limited to the especial field which Mr. Deans discussed. Some of the best points made are those which bear upon the education of the engineer and upon the manner of his entrance upon the active practice of the profession.

"Engineers are often spoken of as narrow and as only being able to talk shop; if there is any truth in this assertion it may be

traced to a lack of a general and broad education in those branches and studies outside of his special work. Whenever possible, let no opportunity be neglected which tends to increase general knowledge and which will assist in laying a broad and thorough foundation for a general education. It is the feeling and belief of the average technical student that the time spent on classical studies, history, literature, and languages is in a manner, wasted, or at least unnecessary. In after years a lack of training in these very branches will be keenly felt by the engineer in his effort to attract attention to his designs and his plans. A profession full of cultured, as well as thoroughly trained, engineers, need have no fear of its standing in the world at large, and that fees of proper size will be expected and paid as cheerfully as to the lawyer or doctor."

In speaking of the commencement of practical life after the college course is finished, Mr. Deans says:

"When taking this first step from college it is most important to shun influential friends who have it in their power to place you in positions beyond your experience; remember it is just as important to progress step by step in the practical work in your profession as it is to follow your regular course in the university."

After the shop and field experience has been gained, the drawing room is the next place to enter.

"The engineering profession may be called the exact profession; probably no other profession can lay claim to the title with the same warrant. The young engineer who has learned to be accurate has made a long step in advance. This is the first habit to be acquired in the drawing room. A beautiful drawing is not essential; a correct one is an absolute necessity. A proper drawing or many drawings might make experience in detailing takes time; one drawing or many drawings might make simply a good draftsman, but it requires many months of actual work at the drawing table to make a good engineer."

One of the best points made by Mr. Deans is the seeming paradox that "after one thoroughly knows how certain work should be done it is no longer necessary for him to do it himself." This may not be

true for all men; if it were there would be no specialists, but it is certainly true for the all-round general engineer or business man. The great thing to be acquired is the knowledge of how other people should do their work so that plans may not only be properly made, but their execution properly supervised.

The ability to write and speak clear lucid English is an acquirement of special value to the engineer, and one which too many of them often lack. It is a well known fact that in the technical and professional societies there are many men of broad and valuable experience who are silent at discussions, and whose names do not appear among the writers of papers. This is mainly because of the diffidence which necessarily accompanies a feeling of inability of expression. The well-educated engineer should not only know how to do things, but he should also be able to set forth what he intends to do beforehand, and to describe what he has done after the work has been accomplished. The man who can show to the interested parties that he knows what he is about, has a far better chance of professional success than his silent companion who may be his superior in ability, but who cannot give expression to his ideas.

Progress in the Iron and Steel Industry.

A GENERAL review of the progress made in the United States during the past ten years in the production of iron and steel, and especially in the reduction of costs, formed the subject of the presidential address of Mr. Charles Kirchhoff at the recent convention of the American Institute of Mining Engineers, and some very interesting points are given. Data furnished from furnaces in the South, in the Pittsburg district, and east of the Alleghenies, all show the material reductions which have been made in costs, together with a greatly increased output.

Thus in the central West the labor cost has been cut down to 46 per cent. of what it was ten years ago, while the coke consumption has been reduced to 86 per cent of the former amount, and the general cost, exclusive of raw materials, has been brought down to 44 per cent. of that of a decade ago. A similar com-

parison shows the reductions which have been made in costs of Bessemer ingots, the total cost per ton having been reduced to 64 per cent. of the earlier amount, while the labor cost is only 75 per cent. of what it was. It is interesting to note that with the general reduction in the total cost, and with the reduced labor cost, there has been an increase of 25 per cent. in the steam cost, showing that it pays to spend money for steam power, presumably to perform the work upon which labor has been saved.

The general sources of the reductions in mining costs are summed up by Mr. Kirchhoff as follows:

"1. Improved methods in mining, by which a larger percentage of coal is recovered. By concentrating the operations a reduced cost for haulage and maintenance of mine tracks is effected.

"2. Improvements in mechanical haulage appliances, like pneumatic haulage, the endless-rope system and the tail-rope system. With the introduction and extension of these there has been coupled an improvement in the character of mine tracks by better grading, the use of heavier rails, the employment of larger ties and of better equipment generally. This has resulted in increased loads, higher speeds, and consequently a larger output at reduced cost per ton for hauling, and has more than compensated for the increased length of haul due to the retreating of the mine workings from the pit mouth.

"3. Improvements due to taking advantage of gravity in hauling loaded and empty cars at the shafts, and to the introduction of automatic dumping appliances on the tippie.

"4. Improvements in mine drainage by judicious concentration, by installing larger pumping appliances, and by the substitution of compressed air for steam for the purpose of draining points in the mines remote from the power plant.

"5. The substitution of steam locomotives and endless gravity rope appliances for mule power for conveying the coal from the bins to the ovens and charging the latter.

"6 The increased output of the coke ovens by increasing their size and by more carefully and scientifically operating them.

"A highly significant statement in connec-

tion with this interest is that while from 1887 to 1897 the cost fell from 100 to 87.3, the earnings of labor increased from 100 in 1887 to 112.5 in 1897."

It is a question whether the progress in the future will be as marked as it has been in the past. When the same methods are continued it is evident that the rate at which economies can be effected must be a continually diminishing one. When, however, the advances are due to the introduction of new methods, it is difficult to place limitations upon the possibilities.

It is only necessary to point to the use of electric appliances in coal mining, to the introduction into the United States on a large scale of European by-product ovens, to the rapid developments lately of the slag cement industry, to the utilization of the blast-furnace gases for power production, to the continuous open-hearth process, and to the latest achievements in rolling-mill work.

Technical knowledge is becoming more and more a common possession of all producing countries. The race is one in which one and then the other contestant is in the lead. The strain of competition is becoming more and more severe. That under such circumstances the mining engineer will not in the future crowd the records of the past it is difficult to believe.

The Problem of Electrolysis.

THE rapid introduction of electric trolley systems has rendered the question of injury to underground water-pipes by electrolysis a problem of ever increasing importance, and in a leading editorial the *Engineering Record* calls attention to the magnitude of the evil.

The first evidence of the straying of electric currents was that of the effect upon telephone circuits and it finally became apparent that the only remedy was the use of all-wire metallic circuits, thus taking the telephone system out of the reach of the leakage currents from the rail returns of the trolley lines.

If the stray currents were injurious to the telephone lines they are far more damaging to water-pipe systems, and the consequences are apt to be much more serious. Any interruption to the water service of a city is far-reaching in its conse-

quences. Power plants would be shut down for lack of water for the boilers, industries would largely come to a standstill and the inconvenience of the first few days would soon become full of menace to the public health.

The causes and action of electrolysis are well understood, and there is nothing mysterious about it. The return current will not only take the path of least resistance, but it will divide itself between several paths in inverse proportion to their respective resistances. If the earth is dry and the track is well bonded, most of the current will return through the latter, but some of the current will pass through the earth. In case the track is of the poorly bonded type, still to be seen in many places, then the proportion of current running through the earth will be greater. The water pipes, being wholly of metal, are the best of conductors, and if they are in the earth in the vicinity of the track the current makes for them.

"It has been shown by a number of engineers that the double trolley system is the only positive remedy for electrolysis. In that system, whether the wires are overhead, as in Cincinnati, or in conduits, as in several cities, the chances for any leakage of current to the ground are infinitesimal. The overhead double trolley is unsightly, and the network of wires is not regarded with favor by fire departments or insurance underwriters. The conduit system is expensive, too expensive for use in many localities. It is evident, therefore, that the problem becomes one of minimizing to the utmost the danger to which water mains are exposed by the present single trolley system of operation."

Assuming therefore that the double conductor system cannot be required in all cases, the next best thing must be done. The water pipes are in the ground, and there they must remain, at least until some subway system is constructed to receive them, and even when good bonding is used some portion of the current is bound to leak to the pipes. It seems, in the light of present knowledge, that these currents may be so reduced by proper precautions as to be without danger in most cases. It is equally evident, however, that the distribution system of the city should be

watched with great care to detect any signs of incipient electrolysis.

"Whether the cost of this inspection must be borne by the city or the railway companies is a question for the courts to decide. Electric railways are certainly a great boon and nothing should be done to restrict their construction and operation except for a greater public good. As a rule, however, they pay little or nothing for the right of using the streets, on which their existence practically depends, and it seems but just that they should be made wholly responsible, not only for the injury which they have done to water-works systems, but also for preventing further injury in the future."

The Theory of Architectural Proportion.

THE fourth and last of a series of articles of peculiar interest to engineers has just been published in the current number of the *Architectural Record*, under the title "Principles of Architecture." It is of value to engineers in acquainting them with a view-point hitherto to them unknown, the view-point of one who looks at his creation solely with regard to its appearance; and in the attempt that these articles make to reduce æsthetic considerations to some approximation to a scientific order and nomenclature, we think they will have the sympathy of the scientifically minded, who have rather been disposed to look askance at the arts of design, owing to their apparent incoherence, and irregularity. That design, æsthetic design, is not quite irreducible to rule, these articles conclusively show. Moreover, they are unique in that it is the first time in the history of art that such an attempt has been made; no other book that handles the subject in this way being in existence.

All discussions of the principles of design in architecture have inextricably mixed up æsthetic, and constructive, and antiquarian ideas, but here is an author who discusses the looks of things without ever hinting at their construction, and eschewing reference to "style," that idol of architects, in a way that is refreshing.

On the contrary the illustrations, which are many, are drawn from all times and countries, in closest juxtaposition, set forth as examples of large masses or small

masses; pointed, square and round masses, and so on.

Perhaps the best part of the treatise is that in which the author tries to show, with some success, that a pleasing proportion between the parts of a building is coincident with some approach to a geometrical similarity in their dimensions, whether in direct or inverse ratio: from its pages at least engineers can learn that which differences their profession from architecture; possibly even they may learn to regard the introduction of a pleasing appearance in constructional work as less irrational and unworthy of consideration than they have hitherto deemed it.

Compound Locomotives.

A PAPER read before the Western Railway Club upon the subject of compound locomotives on the Northern Pacific Railroad, contains some very practical information concerning the actual value of compound locomotives in various branches of service.

It has been assumed in some quarters that the cost for maintenance would be greater for compound than for simple engines, but the experience of Mr. Herr shows that this is not the case. On the contrary, the cost for maintenance, or running repairs, of the compound engines built within the past two years has not been greater than that for simple engines in similar service. Of course the advantage to be expected in the use of the compound engine is that of fuel economy, and the fact that the compound engine does show an economy of about 20 per cent. is now generally conceded. Many railroad men, while freely admitting that the compound locomotive will prove more economical in the consumption of coal in heavy freight service than simple engines of the same weight, do not advocate the compound locomotive for such service because of its assumed liability to failure on account of breaking down, increased cost of maintenance and consequently longer enforced idleness. This view of the case is not sustained by the experience on the Northern Pacific Railroad. Not only are the break downs few, but when they do occur they are rarely due to failure of portions of the mechanism, peculiar to the compounding, but might equally well have occurred with simple en-

gines. Investigation shows that the cost for steam, and no chance to pick up pressure while running down grades, the compound engines showed very clearly the benefit of their economical use of steam.

of maintenance is not on account of broken intercepting valves, leaky receivers, or difficulty in packing or counter balancing the low pressure cylinder. Failures occur on account of broken frames, broken cylinders, unequal wear on the low and high pressure sides of the engine, broken piston rods, cut and badly worn cylinders, and other causes, all of which are clearly traceable to either bad design, construction, or improper care in maintenance. Under these circumstances it is rather an admission of inability to cope with the problems of proper design and maintenance, to refuse to use such a machine because it breaks down.

Admitting the value and economy of the compound system, it seems rather the duty of railroad officials to study the causes of failure, and to remedy the defects which actually appear, so that the weak points may be remedied and a compound locomotive designed which will not fail in service.

The real defect in the compound system, as applied to the locomotive, and indeed in other service, is its lack of flexibility. The economy which is attained by the compound locomotive is at its best when running at a uniform load, a load for which it was designed. When a compound engine is worked under a light load its economy is very much reduced, and for a varying service the simple engine may be found more satisfactory. Compound locomotives have been found very advantageous in heavy fast passenger service, especially so in the very fast service. The reason of this lies in the fact that it is in this service that the boiler is taxed to the utmost, the greatest amount of horse-power is required, and it is necessary to use the steam to the best advantage.

The experience on the Northern Pacific Railroad was gained by putting compound engines on a portion of the divisions, and then by changing the simple engines with the compounds, and thus obtaining a comparative idea of the relative performances of the two types under similar conditions. The result of these trials was that the compound engines did not show any material advantage on the light service, but that for steady, heavy work, on level divisions, where there is a steady pull upon the boiler

The experience on the Northern Pacific Railroad was mainly with two-cylinder compound engines, but experience with Vauclain four-cylinder compounds on the Chicago, Milwaukee and St. Paul road and elsewhere, have shown a fuel-saving of 17 per cent., and nearly a similar economy in reduction of charges for repairs. So far as speed is concerned, it will be remembered that on the Philadelphia and Reading Railway the fast train to Atlantic City, which holds a phenomenal record for speed, has, for several seasons, been drawn by a four-cylinder compound.

The Chicago Drainage Canal.

THE opposition which the city of St. Louis has developed against the pollution of the waters of the Mississippi by the sewage of Chicago, has culminated in a report of a committee appointed for the purpose of setting forth the true state of the matter so far as it can at present be ascertained. This report, while primarily intended to express the protest of St. Louis against what is believed to be a serious menace to the health of that city, is also an interesting discussion of the problems of sewage removal of great cities, and the methods which may be adopted to remove and dispose of sewage without injury to public health.

The Chicago drainage canal, now nearly completed, is to connect the South Branch of the Chicago river to the Desplaines river at Lockport, whence it will flow to the Mississippi. All the sewage now flowing into Lake Michigan is to be intercepted and turned into the Chicago river together with a volume of 20,000 cubic feet of water per minute from the lake, to assist in producing a current and to dilute the sewage. Four results are expected to follow the completion of the drainage canal. 1. Protection of Chicago's water supply from pollution; 2. Purification of the Chicago river and its branches; 3. Discharge of flood waters without overflow; 4. Disposal of all the sewage from the population centring in Chicago, without detriment to other communities. The performance of the first

three points may be conceded for the present, but the fourth one is of vital interest to the city of St. Louis, since the discharge of the sewage of Chicago by the canal means its delivery into the Mississippi, from whence St. Louis draws its water supply, at a point only 45 miles above the city.

Commenting on the subject editorially, *Engineering News* says:

"With the canal in operation, discharging 300,000 cubic feet per minute of sewage and water, and assuming one-twelfth of this to be sewage, the minimum flow of the Mississippi river at St. Louis will be to the sewage of Chicago as 91 to 1. If all of Chicago's sewage now went to the Mississippi, which we understand is not the case, although so assumed in the report, the dilution at the minimum river stage would be as 80 to 1. Although the exact figures are not at hand, the amount of sewage sent down to St. Louis when the canal is put in operation will doubtless be considerably more than at present, but it will be far more diluted. At best the dilution now is probably not over 2 or 3 to 1, while with the canal now in operation, the dilution will be 11 to 1. But the report urges that the Chicago river now acts as a septic tank, and that with the canal in use, the sewage will go seaward faster, and thus a larger number of germs will be carried to a greater distance than at present.

Just what the best remedy is for the prospective injury to St. Louis remains to be seen. It is implied that Chicago is bound to purify the sewage before casting it upon the waters to pollute and contaminate the water supply of a neighboring city. When

it is considered that a sewage purification plant would cost more than fifty million dollars for construction, and three millions for maintenance this seems like asking a great deal; while on the contrary the question of the right to pollute an interstate navigable water-way is still an open question. It may be stated in reply that St. Louis can purify, by filtration, or otherwise, the Mississippi water, if it is found unwholesome, but this is throwing the burden and cost upon the shoulders of the unoffending party.

As *Engineering News* again says:

"The commission recognizes the position in which its report places St. Louis in the matter of water pollution. It urges that by general laws of the United States the pollution of interstate streams must soon be stopped, and that state and municipal regulations will demand the purification of public water supplies under suspicion. It therefore recommends that St. Louis 'so shape its course as to meet both of these propositions before the necessity for meeting them is forced on the city by epidemics, and drastic measures of the general law.'"

In this connection it must not be forgotten that imperfect sewage disposal may be as potent a cause of disease as a polluted water supply, and that no stringent legislation against discharge into streams will help matters unless accompanied with proper provision for effective disposal of sewage in some other way. The wider extension of the bacterial processes may help to solve the problem, however, and make it possible to accomplish both ends, to the benefit of humanity and the elimination of much disease.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, *e.c.* Other abbreviations used in the Index are: *Ill*=Illustrated; *W*=Words; *Anon*=Anonymous.

American Architect. *w*. Boston, U. S. A.
American Electrician. *m*. New York.
Am. Engineer and Railroad Journal. *m*. New York.
American Gas Light Journal. *w*. New York.
American Geologist. *m*. Minneapolis, U. S. A.
American Journal of Science. *m*. New Haven, Conn.
American Machinist. *w*. New York.
Am. Manufacturer and Iron World. *w*. Pittsburg.
American Shipbuilder. *w*. New York.
Am. Soc. of Irrigation Engineers. *qr*. Denver.
Annales des Ponts et Chaussées. *m*. Paris.
Architect. *w*. London.
Architectural Record. *q*. New York.
Architectural Review. *s-q*. Boston, U. S. A.
Architecture and Building. *w*. New York.
Architektonische Rundschau. *m*. Stuttgart.
Australian Mining Standard. *w*. Sydney.
Automotor and Horseless Vehicle Jour. *m*. London.
Berg-und Hüttenmännische Zeitung. *w*. Berlin.
Brick Builder. *m*. Boston, Mass.
British Architect. *w*. London.
Builder. *w*. London.
Bulletin Am. Iron and Steel Asso. *w*. Phila.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m*. Brussels.
California Architect. *m*. San Francisco.

Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Montreal.
Canadian Mining Review. *m*. Ottawa.
Chem. Met. Soc. of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Contemporary Review. *m*. London.
Deutsche Bauzeitung. *b-w*. Berlin.
Dingler's Polytechnisches Journal. *w*. Stuttgart.
Domestic Engineering. *m*. Chicago.
Eclairage Electrique. *w*. Paris.
Electrical Engineer. *w*. London.
Electrical Engineering. *m*. Chicago, Ill.
Electrical Review. *w*. London.
Electrical Review. *w*. New York.
Electrical World. *w*. New York.
Electrician. *w*. London.
Electricien. *w*. Paris.
Electricity. *w*. London.
Electricity. *w*. New York.
Elektrochemische Rundschau. *b-m*. Frankfurt.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnisches Echo. *w*. Magdeburg.
Elektrotechniker. *b-m*. Vienna.
Elektrotechnischer Anzeiger. *s-w*. Berlin.

- Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricità, *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, U.S.A.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s-an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Heating and Ventilating. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Master Steam Fitter. *m.* Chicago.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U.S.A.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
 Ores and Metals. *w.* Denver, Colo.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York.
 Proceedings Engineers' Club. *qr.* Phila.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Públicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, U. S. A.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* Zürich
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, U. S. A.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Western Railway Club Pro. Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, U. S. A.
 Year Book of Soc. of Engs. Univ. of Minn.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutcher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Chimney.

A Cincinnati Steel Chimney. Illustrated description of the details of a 230 ft. steel chimney. 1600 w. Eng Rec—April 1, 1899. No. 26886.

Cold Storage.

Construction of a Cold Storage Building. From *Carpentry & Building*. Illustrated description of a building erected at Fort Sheridan, Ill. 700 w. Met Work—April 22, 1899. No. 27126.

Elevators.

See Mechanical Engineering, Machine Works.

Exposition.

Exposition of 1900. Civil Engineering and Transportation Buildings. (Exposition de 1900. Palais du Génie Civil et de Moyens de Transport.) R. Weil. Especially devoted to the methods of raising the frames and erecting the structural work of these important portions of the exposition buildings. 3500 w. 1 plate. Génie Civil—March 18, 1899. No. 27211 D.

Fire-proofing.

Effects of Heat upon Natural Stone and Burnt Clay. Charles J. Everett. Gives a report of investigations made after great conflagrations, also giving opinions of others. 2800 w. Br Build—March, 1899. No. 26910 C.

Fire Stops.

The Massachusetts Rules for the Provision of Fire Stops in Buildings. A copy of the specifications covering the requirements for preventing the spread of fire in buildings, with comments. 1200 w. Eng News—April 6, 1899. No. 26945.

Hospitals.

Massillon State Hospital. Illustrated description of the grounds, buildings, heating, ventilation, plumbing, water supply and sewage disposal of a large Ohio institution for the insane. 2000 w. Eng Rec—April 15, 1899. Serial. 1st part. No. 27046.

The Buffalo General Hospital. Illustrates and describes the structural and hygienic features of a large hospital building recently opened. 2000 w. Eng Rec—April 8, 1899. No. 26962.

Kursaals.

Continental Kursaals. Brief description of these public assembly halls at the various resorts. 2300 w. Arch, Lond—March 31, 1899. No. 26991 A.

Libraries.

Public Libraries. J. M. Brydon and F.

J. Burgoyne. The paper by Mr. Brydon discusses what has recently been done in library building, giving illustrations. Mr. Burgoyne considers the planning and fitting. Discussion. 13000 w. Jour Roy Inst of Brit Archts—Feb. 25, 1899. No. 26926 D.

Moving Buildings.

Moving an Iron Building in Paris. Describes the method employed in moving the framework of a 98 x 492 ft. building a distance of about 850 ft. Eng Rec—April 8, 1899. No. 26966.

Office-Buildings.

The Equipment of Tall Office Buildings in New York City. Reginald Pelham Bolton. The construction of so many buildings of this character has brought about a competition that makes the economical equipment and operation of importance. This subject is discussed and some of the problems presented. Ill. 4800 w. Trans Am Soc of Mech Eng—May, 1899. No. 27301 D.

The Machinery of a Great Office Building. F. E. R. Illustrates and describes the elevators, engines, generators and heating system of the Ivins Syndicate Building, in New York. 3400 w. Mach, N. Y.—April, 1899. No. 26844.

Stable Construction.

The Wanamaker Stables, New York. Illustrated description of the buildings employed by a large retail dry-goods house for its delivering department. 2100 w. Eng Rec—April 22, 1899. No. 27137.

Steel Framing.

Column and Beam Connections in the Williamson Building. Illustrates new details adopted in a Cleveland office building, 16 stories high. 450 w. Eng Rec—April 22, 1899. No. 27135.

Towers.

The Theory of Dome and Tower Construction. (Zur Theorie der Kuppel und Turmdacher.) H. Müller-Breslau. A further discussion of the principles of framing the members of metal domes and spires, and the computation of stresses therein. 5,000 w. Zeitschr d Ver Deutscher Ing—April 8, 1899. No. 27207 D.

Workmen's Homes.

Dwellings for the Working Classes Financially Considered. Peter Fyfe. From a lecture delivered before the Glasgow and West of Scotland Architectural Craftsmen's Society. An examination of various dwellings to determine whether sanitary homes can be rented to this class without financial loss to the owners. 3300 w. Brit Arch—April 7, 1899. No. 27066 A.

HEATING AND VENTILATION.**Heating Plant.**

The Central Heating Plant of the University of Wisconsin, at Madison, Wis. Storm Bull. Describes the plant, with tests, of interest because of the difficulties overcome. Ill. 7400 w. Trans Am Soc of Mech Eng—May, 1899. No. 27300 D.

Hospital.

Heating and Ventilating Fletcher Hospital, Kalamazoo, Mich. Illustrates and describes a fine installation. 1500 w. Heat & Ven—April, 1899. No. 27183.

Hot-Air Furnaces.

The Metal Worker Hot-Air Furnace Competition. Albert N. Parker. The first prize essay of a competition for heating a school building with hot-air furnaces. Ill. 2500 w. Met Work—April 1, 1899. No. 26843.

Interior Ventilation.

The Working of Ventilation Systems. Comment on the report of W. N. Shaw, to the Local Government Board, England, concerning the ventilation and warming of dormitories, workshops and schools. 1800 w. Jour Gas Lgt—April 4, 1899. No. 27053 A.

Modern Practice.

Modern Practice in Steam Heating and Ventilation. William S. Monroe. Chapter first describes the methods used in heating buildings of different classes and is introductory to more detailed information. 2200 w. Eng Rec—April 15, 1899. Serial. 1st part. No. 27047.

PLUMBING AND GASFITTING.**Drainage.**

House Drainage and Sanitary Fitments. Gerard J. G. Jensen. Chapter first considers form and materials of piping for drainage work. Ill. 1500 w. San Rec—April 7, 1899. Serial. 1st part. No. 27065 A.

London By-Laws as to the Drainage of Buildings. A copy of the proposals now under consideration, with editorial comment. 9800 w. Builder—April 1, 1899. No. 26995 A.

Master Plumbers.

The Position of the Master Plumber as Regards the Sewerage of Cities and Towns. James F. Traynor. Read at the New Orleans convention. The work of the plumber in connection with water supply, sewerage, general sanitation, etc.

2500 w. San Plumb—April 15, 1899. No. 27138.

Public Baths.

The Municipal People's Baths of Vienna. W. P. G. Describes two of these bath-houses, giving illustrations of details. 2700 w. Arch & Build—April 15, 1899. No. 27023.

Sanitation.

The Sanitation of Dwellings in England. Barrister F. Fletcher. The present article deals with the site, the drainage, and the heating, lighting and ventilation. 3300 w. Arch Rec—April-June, 1899. No. 27182 C.

Sewerage.

Perfect Sewerage in Relation to Public Health. James J. Wade. Read before the Nat. Ass'n of Master Plumbers, at New Orleans. Showing the dependence of public health upon perfect sewerage and plumbing. 2200 w. Dom Engng—April, 1899. No. 27108 C.

Perfect Sewerage in Relation to Public Health. Louis F. Meyer. The work of the plumber in the prevention of disease, and in promoting sanitation. 1700 w. San Plumb—April 15, 1899. Serial. 1st part. No. 27139.

Sutro Baths.

Sutro Baths of San Francisco. F. W. Parsons. Illustrated description. 700 w. Sci Am—April 29, 1899. No. 27318.

MISCELLANY.**Building Stone.**

See Civil Engineering, Materials.

Chemistry in Building.

Chemistry as an Aid in Building. Calls attention to the subjects connected with building with which chemistry is associated. 1300 w. Builder—April 8, 1899. No. 27069 A.

Composition.

Principles of Architectural Composition. John Beverley Robinson. The last of a series of articles showing that a pleasing appearance in constructional work is worthy the consideration of engineers, and discussing the principles of design. Ill. 5500 w. Arch Rec—April-June, 1899. No. 27328 C.

Glue.

Glue Testing. S. Rideal. Gives the chemical examination and physical tests, etc. 4000 w. Builder—April 15, 1899. No. 27157 A.

CIVIL ENGINEERING**BRIDGES.****Alexander III.**

Notes on the Construction of the Alex-

ander III Bridge. (Notes sur la Construction du Pont Alexandre III.) MM. Résal and Alby. A further contribution to

the account of this great work; dealing principally with the construction of the hinged arches and with their erection. 16-000 w. 5 plates. *Ann des Ponts et Chaussées*—4 Trimestre, 1898. No. 27227 E + F.

The Construction of the Alexander III Bridge, Paris. Jacques Boyer. A very fully illustrated account of the design, construction and erection of the latest and most remarkable bridge across the Seine; one of the conspicuous features of the coming exposition. 4500 w. *Engineering Magazine*—May, 1899. No. 27283 B.

Arch.

A Stone Arch Bridge of Moderate Cost. Illustrates a small stone arch built at Kankakee, Ill. 300 w. *Eng News*—March 30, 1899. No. 26862.

Budapest.

The Schwurplatz Bridge over the Danube at Budapest. (Die Schwurplatz-Donaubücke in Budapest.) A. Meissner. Description of this new chain-suspension bridge over the Danube, with plate of details and map of approaches. 2000 w. 1 plate. *Oesterr Monatschr f d Oeffend Baudienst*—April, 1899. No. 27221 D.

Concrete.

The New Stauffacher Bridge at Zurich. (Die Neue Stauffacher-Brücke in Zürich.) The engineer's specification, with details and elevation of this handsome béton arch of 130 feet span. 2000 w. *Schweizerische Bauzeitung*—March 4, 1899. No. 27247 B.

Falsework.

Failure of Falsework of New York Bridge. Illustrated description of bridge falsework which fell April 11, killing five men and injuring over twenty. 600 w. *Eng Rec*—April 15, 1899. No. 27039.

Foundations.

The New York Tower Foundations, New East River Bridge. Illustrated account of the method of constructing these piers, especially the means for working under compressed air. Several new forms of air locks are explained. 2000 w. *Eng Rec*—April 1, 1899. No. 26882.

Glasgow.

The New Glasgow Bridge. From the *Scotsman*. General description of the work of rebuilding of a bridge over the Clyde. 1100 w. *Archit, Lond*—April 14, 1899. No. 27155 A.

Korea.

A Korean Bridge. Illustrated description of the first steel bridge in Korea, a railway structure having a footway outside one truss. The bridge is 2,000 ft. long and has ten spans. 700 w. *Eng Rec*—April 15, 1899. No. 27036.

Loads.

General Criterion for Position of Loads

Causing Maximum Stress in Any Member of a Bridge Truss. F. H. Cilley. Contribution to the discussion of the paper by L. M. Hoskins. 400 w. *Pro Am Soc Civ Engs*—April, 1899. No. 27308 E.

Railroad Bridge.

Erection of Bridge 69, Pennsylvania Railroad. Illustrated description of the methods employed in erecting a bridge of 236 ft. span on one of the busiest trunk lines in the country without the interruption of traffic. The new span was erected on falsework on one side of the line and when it was completed the old span was moved to the other side and the new one substituted, the time occupied in moving being less than 14 minutes. 3600 w. *Eng Rec*—April 22, 1899. No. 27128.

Reconstruction.

Reconstruction of the Penrose Ferry Bridge, Philadelphia. Illustrated description of some novel foundation methods for bridge piers and of heavy timber approaches. 2800 w. *Eng Rec*—April 8, 1899. No. 26959.

Reinforced Concrete.

The X Bridge at Mans. F. E. R. From *La Revue Technique*. Describes a bridge of originality of construction and pleasing appearance. Ill. 2800 w. *Ind. Engng*—March 25, 1899. No. 27173 D.

Rhine Bridges.

The Bridges Across the Rhine, Near Bonn and Dusseldorf, Germany. Fritz Mueller von der Werra. Illustrates and describes the important features of two imposing structures opened to traffic in 1898. 4300 w. *Eng News*—April 20, 1899. No. 27110.

The New Rhine-Bridges at Bonn and Dusseldorf. (Die Neuen Rheinbrücken zu Bonn und Düsseldorf.) A comparative study of these latest bridges across the Rhine, with numerous details of the construction. 7500 w. 1 plate. *Zeitschr d Ver Deutscher Ing*—March 25, 1899. No. 27203 D.

CONSTRUCTION.

Dams.

The Construction of High Earth Dams. Review of a paper by W. L. Strange before the Inst. of Civ. Engs., and of the discussion it elicited. 6000 w. *Eng Rec*—April 15, 1899. No. 27043.

The Periae Dam. J. S. Chandler. Illustration and brief description of this great dam in India, which provides irrigation for 150,000 acres of land. 500 w. *Sci Am Sup*—April 8, 1899. No. 26935.

The Resistance of Dam Framing. (La Résistance de Fermettes de Barrages.) M. Claise. Giving the results of tests of the strength of the frames used to support the sections of a movable dam of the needle type, and the method adopted to increase

stiffness. 3000 w. 1 plate. *Ann des Ponts et Chaussées*—4 Trimestre, 1899. No. 27-228 E + F.

Foundations.

The Calculation of I-Beam Grillage Foundations. J. B. Nau. Submits an easy and rapid method of making these calculations, giving diagram. 1000 w. *Eng News*—April 20, 1899. No. 27112.

Reinforced Concrete.

Construction in Reinforced Cement. (Constructions en Ciment Armé.) N. de Tedesco. A paper before the Society of Civil Engineers of France, giving the latest advances in reinforced concrete construction, with data of tests. 5000 w. *Soc Ing Civ de France*—Jan., 1899. No. 27-235 G.

See also Bridges.

Roads.

Use of Tar in Road Making. A. H. Campbell. Extract from a paper read before the Assn. of Munic. and Co. Surv's, on the construction of roads of tarred macadam. 2000 w. *Gas Eng's Mag*—April 10, 1899. No. 27303 A.

Truss.

Graphical Determination of Maximum Stresses in a Truss. (Graphische Ermittlung der Grössten Stabkräfte in einem Fachwerksbalkenträger.) Prof. J. Melan. Describing a simple graphical method, with diagrams showing the application. 2000 w. *Oesterr Monatschr f d Oeffent Baudienst*—April, 1899. No. 27223 D.

Tunnel.

The Beach Broadway Tunnel. Illustrates and describes the tunnel built in 1869 under Broadway, New York, and the car used in it. 1000 w. *Sci Am*—April 15, 1899. No. 27013.

The Proposed Thames Tunnel. Editorial Discussion of the tunnel to be constructed under the Thames from Shadwell to Rotherhithe, making suggestions for improvements. 1000 w. *Engr, Lond*—April 7, 1899. No. 27087 A.

HYDRAULIC AND MARINE.

Artesian Wells.

Savannah and Its Artesian Wells. Describes the methods adopted to restore the water to old wells when it had failed. 600 w. *Fire & Water*—April 15, 1899. Serial. 1st part. No. 27062.

Canals.

Physical and Commercial Aspects of the World's Ship-Canals. E. L. Corthell. A critical comparison of the constructive features and operative details of existing ship canals, enabling the possibilities of future undertakings to be studied in the light of previous experience. 4500 w. *Engineering Magazine*—May, 1899. No. 27-288 B.

The Economic Relation of the Proposed Deep Waterways to the State of New York. George W. Rafter. Reviews the improvements made in transportation by the way of the Great Lakes, Oswego and Mohawk route, especially since the construction of the Erie Canal, and discusses the present project to permit large boats to pass from the Great Lakes to tide water. 3800 w. *Tech Quar*—March, 1899. No. 27022 E.

The Galops Canal. Illustrates and describes the improvements on this canal in Ontario, with remarks on the general improvement of the canal system. 1100 w. *Fire & Water*—April 1, 1899. No. 26-894.

The Nicaragua Canal and Its Rivals. Reviews the various bills presented during the last session of the U. S. Congress, and the question as it now stands. 4500 w. *Engr, Lond*—April 7, 1899. No. 27081 A.

The Report of the St. Louis Commission on the Chicago Drainage Canal. The report in full is given, in view of its interstate and international complications, and the discussion of the engineering and legal principles. 6000 w. *Eng News*—April 27, 1899. No. 27342.

The Soulanges Canal. Describes the 14-mile canal passing boats of 2,000 tons on a 14-ft. draft around Cascades, Split Rock, Cedars and Coteau Rapids in the St. Lawrence River. 1400 w. *Eng Rec*—April 8, 1899. No. 26958.

Coasts.

Sea-Coast Protection. W. H. Wheeler. Describes the causes of coast destruction and the remedies adopted in various lands. 2200 w. *Engr, Lond*—April 7, 1899. Serial. 1st part. No. 27080 A.

Dock.

New York, New Haven & Hartford Dock at New London, Conn. E. M. Smith. Illustrates and describes a dock 500 ft. long by 100 ft. wide now being built for the use of passenger and freight trains meeting the boats of the Norwich, Stonington and Fall River lines. 800 w. *R R Gaz*—April 7, 1899. No. 26950.

Dredges.

Report on Sand-Pump Dredgers. W. R. Haughton. Gives general description with illustrations, and discusses the requirements for working on the Ganges. 2000 w. *Ind Engng*—Feb. 25, 1899. No. 26849 D.

Filtration.

Filtration at Pittsburg. Extracts from a report of the committee appointed to investigate methods of filtration. Considers sand and mechanical filtration. 1800 w. *Fire & Water*—April 22, 1899. No. 27181.

Water Filtration, Zurich, Switzerland. James H. Fuertes. Illustrated account of

the filter beds and a statement of the work they accomplish. 1100 w. Eng Rev—April 22, 1899. No. 27130.

Ground Water.

Influence of Rain and Air-Temperature upon the Temperature and Flow of Ground Water. (Abflussmengen und Temperaturschwankungen des Grund wassers in ihren Beziehungen zur Regenhohe und Lufttemperatur.) Adolph Friedrich. Tabulated deductions, with diagrams, from data obtained from many observations in Austria. 3000 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1899. No. 27224 D.

The Ownership of Underground Water in New York. Gives the legal views held by the New York courts on the ownership of ground water, and explains the reason for giving an injunction to a farmer to restrain pumping such a supply for municipal use, when refusing an injunction to a rival water-works for the same purpose. 800 w. Eng Rec—April 15, 1899. No. 27041.

Havre.

The Improvement Works at the Port of Havre. (Les Travaux d'Amelioration du Port du Havre.) G. Leugny. With a hydrographic plan of the harbour, and a description of the new dykes and dock basins. 3000 w. Revue Technique—March 25, 1899. No. 27217 D.

Hydrography.

The Information Service of the Vienna Hydrographic Bureau. (Der Wasserstands-Nachrichtdienst der K. K. Hydrographischen Landesabtheilung in Wien.) A full account of the observations of the level of the Danube at various points, and the system of sending out information of floods. 4500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—April, 1899. No. 27222 D.

Ice Shields.

Ice Shields at the Buffalo Water-Works. Illustrated description of the apparatus used at Buffalo to keep stream and anchor ice out of the pumping wells. 500 w. Eng Rec—April 1, 1899. No. 26881.

Lancaster, Pa.

The Water Problem of Lancaster, Pa. A review of the proposed engineering works for conserving, clarifying and purifying the present water supply. 1500 w. Eng Rec—April 22, 1899. No. 27133.

Litigation.

The Reversal of the Danville Water-Works Decision. Reviews an opinion of the Illinois Supreme Court which declares a contract between a water company and a city, running for several years, not binding so far as the schedule of rates in the contract is concerned. 1400 w. Eng Rec—April 8, 1899. No. 26957.

The Rogers Park Water-Works Case. Full text of a decision by the Illinois Supreme Court which declares not binding a contract between a local water company and the town of Rogers Park, now part of Chicago. 3000 w. Eng Rec—April 8, 1899. No. 26965.

Mississippi.

The Problem of the Mississippi. Herman Haupt. A discussion of the problem of maintaining a navigable channel in low water and preventing the destruction of life and property by floods. 3500 w. Jour Fr Inst—April, 1899. No. 26952 D.

Nile.

The River Nile. E. A. S. A sketch map showing the numerous sources of the river is given, and part first gives information concerning the lakes. 1200 w. Ind Engng—March 18, 1899. Serial. 1st part. No. 27144 D.

Philadelphia.

The Water Problem in Philadelphia. Address by Prof. Edgar Marburg, on the reasons for the typhoid fever outbreak in the early months of 1899. Also editorial. 3000 w. Eng Rec—April 8, 1899. No. 26963.

Pumps.

See Mechanical Engineering, Hydraulics.

Purification.

The Purification of Public Water Supplies. W. N. Twelvetrees. Abstract of a paper presented at a recent meeting of the British Civ. & Mech. Engs. Considers filtering media, methods of purification, etc. 1600 w. Jour Gas Lgt—April 4, 1899. No. 27055 A.

Rockford, Ill.

Difficult Engineering Problem Solved in Rockford's New Water-Works. On the difficulties encountered and overcome in the construction of the new water supply plant. Ill. 1300 w. Munic Engng—April, 1899. No. 26892 C.

River Correction.

Improvement Works upon the Arzen-Ain-Sefra Railway, Algeria. (Travaux sur le Chemin de Fer d'Arzew à Ain-Sefra, Algérie.) Showing the application of embankment methods, similar to those employed in Switzerland, for the protection of a railway from damage by river overflow. 1200 w. Génie Civil—March 18, 1899. No. 27212 D.

Stand-Pipe.

New Water Tower at Schenectady, N. Y. Illustrated description of the construction of an enclosed stand-pipe of 6,000,000 gallons capacity. 1000 w. Eng Rec—April 1, 1899. No. 26885.

Submerged Pipe.

Submerged Pipe-Laying at Delray. Illustrated account of method of laying 72-inch pipe across the Rouge River, with description of a special joint for such work. 600 w. Eng Rec—April 15, 1899. No. 27-037.

Tides.

The Distribution of Velocity in Tidal Currents. (Distribution des Vitesses dans les Courants de Marée.) M. Bomdelles. A general discussion of tidal currents, as influenced by the configuration and depth of the harbour, based upon numerous observations made in France and elsewhere. 6500 w. 4 plates. Ann des Ponts et Chaussées—4 Trimestre, 1898. No. 27-225 E + F.

Water Rights.

New French Law Regulating the Use of Water. Law to regulate the ownership and the regimen of rain water, spring water, and all flowing streams, and to determine the rights of individuals, communities, etc. 1400 w. Eng News—April 13, 1899. No. 27019.

Watershed.

The Fight for the Derwent Watershed. Some details of the three schemes of Derby, Leicester and Sheffield, (Eng.) for obtaining possession of the Derwent and its supply. 1700 w. Jour Gas Lgt—April 18, 1899. No. 27312 A.

Water Tank.

The New Elevated Water Tank at Jacksonville, Fla., R. N. Ellis. Perspective view and detail drawing with description. 1000 w. Eng News—April 27, 1899. No. 27338.

Water Works.

The Amballa Water-Works. Abstract of a paper by Charles E. V. Goument before the Inst. of Civ. Engs. (England), on an Indian Water plant, drawing water from wells, and conducting it to the town through an 8-inch main by gravity and pumping combined; the plant has several unusual features. 2000 w. Eng. Rec—April 22, 1899. No. 27132.

MATERIALS.

See also Mechanical Engineering, Materials.

Building Stone.

Building Stones—Elements of Strength in Their Constitution and Structure. Alexis A. Julian. Considers the foundations on which methods of testing should be based to determine their strength. Ill. 10700 w. Jour Fr Inst—April, 1899. Serial. 1st part. No. 26951 D.

Cement.

Government Tests for Cement. A copy of the tests and conditions enforced by

the Russian Government, in selection of Portland cement. 1000 w. Stone—April, 1899. No. 27099 C.

Concrete.

On the Theory of Concrete. George W. Rafter. Explanations condensed from the author's report to the N. Y. State Engineer, on tests made, with tabulated results. 2200 w. Pro Am Soc Civ Engs—April, 1899. No. 27306 E.

Mortar.

The Mechanism of the Disintegration of Hydraulic Mortars. (Sur le Mécanisme de la Désagrégation des Mortiers Hydrauliques.) H. Le Chatelier. A note to the French Academy, developing a theory for the hitherto unexplained action sometimes occurring in hydraulic mortar. 1000 w. Comptes Rendus—March 13, 1899. No. 27241 D.

Paving-Brick Tests.

Tests of Paving Brick at the Iowa State College. Illustrated account of experiments to determine the relative importance of different kinds of tests. 3500 w. Eng Rec—April 1, 1899. No. 26884.

Preserving Wood.

Haskinized Wood. Frank Caws. An explanation of this invention for rendering timber decay-proof. 4800 w. Jour Roy Inst of Brit Archts—March 11, 1899. No. 26929 D.

Road Stone.

Description of Apparatus and Methods Used by the Massachusetts Highway Commission in Investigating the Properties of Road Building Stone. Describes the work as carried on in the engineering laboratory of Harvard University. 1600 w. Stone—April, 1899. No. 27098 C.

MEASUREMENT.**Planimeters.**

Some Observations on the Use of Polar Planimeters. Walter W. Patch. Notes collected during several years' experience furnishing facts relating to the degree of accuracy of results obtained. 2000 w. Eng News—April 13, 1899. No. 27018.

Survey.

A Great Cadastral Survey. A brief outline of the character and extent of the work which will be necessary in revising and renewing the cadastral survey of France, which is under consideration. 1600 w. Engr, Lond—April 7, 1899. No. 27082 A.

MUNICIPAL.**American Municipalities.**

An English Municipal Engineer's Visit to America. George Livingstone. Read before the Incor. Assn. of Munic. and Co. Engs., London. Notes on traffic, paving, cleansing, dust removal, water supply,

baths, buildings, etc. 9400 w. Builder—April 8, 1899. No. 27070 A.

London, Ont.

The Sewerage of London, Ont. Abstract of a paper by W. T. Ashbridge before the Canadian Soc. of Civ. Engs., on methods followed in constructing sewers under difficult conditions. 1400 w. Eng. Rec—April 22, 1899. No. 27134.

Refuse.

Refuse Destruction. Editorial on the interesting report of Messrs. Kelvin and Barr on the subject of refuse destruction in connection with the Horsfall furnace. 2000 w. Engng—April 7, 1899. No. 27079 A.

Sewage.

Sewage Precipitation Works of New Rochelle, N. Y. H. de B. Parsons. Illustrated description. 1200 w. Stevens Ind—April, 1899. No. 27125 D.

Sewage Disposal.

Sewage Disposal, Kingston-on-the-Thames, England. James H. Fuertes. Illustrated description of a plant treating the sewage of a population of 43,000 by the A B C process, which, in its latest form, is described in detail. 1100 w. Eng Rec—April 8, 1899. No. 26960.

Sewer Repairs.

Sewer Repairs, Cincinnati, O. Describes the method of reconstructing the invert of a 9½ ft. sewer without stopping the flow of sewage. 1000 w. Eng Rec—April 15, 1899. No. 27042.

Sewers.

Maintenance of Sewers at Providence, R. I. Allen Aldrich. Results from an experience of 26 years. Ill. 4800 w. Eng News—March 30, 1899. No. 26860.

Sewer Catch-Basin and Cleaning Ap-

paratus at Wilmington, Del. T. Chalkley Hatton. A brief description of a catch-basin and apparatus invented by the writer, which has proved satisfactory and economical. Ill. 700 w. Eng News—March 30, 1899. No. 26859.

The North Yarra Sewer Tunnel, Melbourne. Illustrated abstract of a paper by H. V. Champion, describing a tunnel in bad soil, driven by means of a shield and compressed air. 4000 w. Eng Rec—April 8, 1899. No. 26961.

Street-Cleaning.

Street Cleaning in Washington. An account of the methods followed in the city named, where both hand and machine cleaning is in vogue. 1400 w. Eng Rec—April 22, 1899. No. 27129.

Street Grades.

Street Grades and Cross-Sections in Asphalt and Cement. J. M. Evans and A. F. Harley. Contributions to the discussion of Robert P. Woods' paper on this subject. 1700 w. Pro Assn Soc Civ Engs—April, 1899. No. 27307 E.

MISCELLANY.

Porto Rico.

Engineering Features of San Juan, Porto Rico. H. M. W. A letter containing a statement of the general character of the engineering work in progress. Ill. 3000 w. Eng News—March 30, 1899. No. 26864.

Wrecking.

The Recovery of a Titan Crane at Mastaganem. (Repêchage d'un Titan à Mastaganem.) I. Pronteau. An account of the recovery of a powerful crane which had been blown into the sea from a breakwater at Mastaganem, Algeria. 1200 w. Revue Technique—March 25, 1899. No. 27215 D.

ELECTRICAL ENGINEERING

COMMUNICATION.

Bandot System.

The Bandot System of Telegraphy. E. Bernard. Illustrates and describes this printing telegraph system which has been adopted by the French Government, and is used also in other countries of Europe. 1600 w. Elec Rev, N Y—April 12, 1899. No. 27024.

Coherer.

A Very Sensitive Coherer. (Sur un Cohéreur Très Sensible.) T. Tommasina. A communication to the French Academy describing a very sensitive coherer composed of granules of carbon between carbon points. 1000 w. Comptes Rendus—March 13, 1899. No. 27242 D.

Exchanges.

Automatic Telephone Exchanges. Describes briefly the system as applied to a small exchange of one hundred subscribers. Ill. 1300 w. Builder—April 15, 1899. No. 27156 A.

Foreign Service.

The Telephone Service in Foreign Countries. Information obtained by British Consuls is summarized. 4000 w. Elect'n, Lond—March 24, 1899. No. 26870 A.

Italy.

The Telephone in Italy. (La Telefonia in Italia.) Giacinto Motta. An address showing the extensive use of the tele-

phone in various countries and comparing the progress made by Italy with other parts of the world. The formation of one general organization for the whole of Italy is urged. Two articles. 7500 w. *L'Elettricità*, April 1, 8, 1899. No. 27271, each B.

Pacific Cables.

The Coming Pacific Cable. Considers the chief physical and mechanical difficulties of the undertaking, with comments on the possibility of the enterprise being put through by the United States rather than by Great Britain. 1700 w. *Ind and Ir*—March 24, 1899. No. 26871 A.

Paper Cables.

Paper Cables as Used in Telephony, etc. E. J. J. Illustrates and describes the method of applying paper insulation, the laying of the cables, construction of the terminals, etc. 2200 w. *Elec Rev, Lond*—April 7, 1899. No. 27073 A.

Space Telegraphy.

Telegraphing Without Wires. (Télégraphie sans Fil.) Paul Janet. A discussion of currents of high frequency and electrical oscillations, especially in connection with the experiments in space telegraphy in Paris by M. Ducretet. 5000 w. *Soc Ing Civ de France*—Feb., 1899. No. 27-238 G.

Wireless Telegraphy. J. A. Fleming, in the *London Times*. On the importance of Signor Marconi's methods and the results he has brought about. 900 w. *Ry & Engng Rev*—April 22, 1899. No. 27177.

Wireless Telegraphy. Rankin Kennedy. An explanation of this transmitting force from one vertical wire to another. 1600 w. *Elec Rev, Lond*—April 14, 1899. No. 27-153 A.

Submarine.

The History of the Submarine Telegraph. A compilation giving the history of submarine telegraphy in chronological order. 3000 w. *Elec Rev, N. Y.*—April 26, 1899. No. 27311.

Telephony.

Improvements in Telephone Systems. Kempster B. Miller. Part first gives an illustrated description of a recent patent of G. K. Thompson for connecting lines of old and new systems, or with each other, without any special attention in the part of the operator. 1600 w. *Elec Wld & Elec Engr*—April 15, 1899. Serial. 1st part. No. 27052.

Telephones in Canada. An account of the service rendered by the Bell Telephone Co., which practically controls the business. 1000 w. *U. S. Cons Repts*, No. 403—April 8, 1899. No. 27090 D.

Telephones. John Gavey. A detailed account of telephones and telephone exchanges, especially the service in Great Britain. Also discussion. 6000 w. *Jour*

Soc of Arts—April 14, 1899. No. 27180 A.

The Post-Office and Telephony. S. Alfred Varley. On the evil consequences of the policy adopted in England, in making telephony a Post-Office monopoly. 2400 w. *Elec Rev, Lond*—March 31, 1899. Serial. 1st part. No. 27001 A.

Testing Sets.

Inspectors' Portable Testing Sets. H. P. Clausen. Considers the requirements of a properly designed inspector's telephone test set and gives illustrated descriptions of commercial forms. 2500 w. *Elec Engng*—April, 1899. No. 27118.

ELECTRO-CHEMISTRY.

Alkali Works.

The Castner-Kellner Alkali Works at Weston Point. John B. C. Kershaw. An illustrated detailed description of the process, and introductory remarks concerning the slow progress of electrolytic processes in England. 3300 w. *Elec Rev, Lond*—March 31, 1899. No. 27000 A.

Batteries.

Relation Between the Heat Given Off Inside Voltaic Couples and the Heat Capable of Being Transmitted to the Circuit under the form of Chemical Energy. Dr. D. Tommasi. An explanation of investigations and results. 1300 w. *Elec. Rev, Lond*—April 7, 1899. No. 27074 A.

Diaphragms.

The Action of Membraneous Diaphragms in the Electrolysis of Salts. (Ueber das Verhalten von Membranen bei dem Elektrolytischen Transport von Salzen.) Dr. W. Bein. A very complete discussion of experiments with various membranes and solutions, forming an important contribution to the subject of electrical dialysis. 4000 w. *Elektrochemische Zeitschr*—April 1, 1899. No. 27268 F.

Electrodes.

Experiments with Carbon Electrodes. (Versuche mit Kohlenelektroden.) Dr. J. Zellner. A very full discussion of the advantages in the use of carbon electrodes in electrolytic processes, with tables of data for various solutions. 3000 w. *Zeitschr f Elektrochemie*—April 6, 1899. No. 27267 F.

Electrolysis.

Electrolysis in Battle Creek, Mich. W. W. Brigden. A description, with map, of the injury to water and gas pipes by electric currents wandering from a street railway. 900 w. *Eng Rec*—April 15, 1899. No. 27040.

Electro-Metallurgy.

Electrometallurgy. (L'Electrometallurgy.) P. Chalon. A review of the progress which has been made in winning and refining metals, comparing electrolytic and electrothermic methods. 3500 w. *Rev*

Univ des Mines—March, 1899. No. 27-252 G.

Galvanising.

Methods of Cold Galvanising. (Galvanisation à Froid.) M. Quivy. A study of the process of electro-chemical zincing of iron, with data as to baths, current, and operative details. 5000 w. Bull de la Soc d'Encour—March, 1899. No. 27-229 G.

ELECTRO-PHYSICS.

Accumulators.

Gas Electric Accumulators. (Leo Accumulateurs Electriques à Gaz.) A discussion of the improvements in gas storage batteries for electricity suggested by M. de Nansouty, showing the possibility of producing an accumulator of much less weight than has heretofore been possible. 2000 w. Revue Technique—March 25, 1899. No. 27216 D.

Alternating Currents.

Experiments on Alternate Current Arcs by Aid of Oscillographs. W. Duddell and E. W. Marchant. Abstract of a paper presented to the Inst. of Elec. Eng., London. Gives some of the more important results developed by the investigation. 3600 w. Elect'n, Lond—April 14, 1899. Serial. 1st part. No. 27149 A.

Galvanic Currents.

The Theory of Dissociation as Applied to Galvanic Currents. A von Oettingen. Deals with the phenomena attending electric currents in their entrance into, passage through, and exit from fluid electrolytes. 5800 w. Jour of Chem & Met Soc of S. Africa—Feb., 1899. No. 27146 E.

Induction Coils.

The Induction Coil Spark Analyzed. Describes the apparatus used, and investigations by Walter, which give light on this subject. Ill. 900 w. Elec Rev, Lond—April 7, 1899. No. 27076 A.

Interrupter.

Experiments with the Wehnelt Interrupter. George T. Hanchett. An account of recent experiments and results obtained by the writer. 1400 w. Elec Wld & Elec Engr—April 8, 1899. No. 26969.

Interrupting Devices for Induction Coils. (Unterbrechungsvorrichtungen für Induktionsapparate.) F. Dessauer. A general discussion of the subject, followed by a description of improved mechanically-operated mercury interrupters. 4000 w. Elektrotech Zeitschr—March 23, 1899. No. 27263 B.

The Wehnelt Electrolytic Interrupter. (Sur l'Interrupteur Electrolytique Wehnelt.) A. Blondel. A note to the French Academy reviewing the author's experiments, and discussing the action of the

device. 1000 w. Comptes Rendus—April 4, 1899. No. 27246 D.

GENERATING STATIONS.

Accumulators.

Motor-Dynamos or Accumulators. Alton D. Adams. Showing the motor-generator often proves more desirable than the accumulator. 1800 w. St Ry Jour—April, 1898. No. 26922 D.

The Application of the Storage Battery. C. D. Wood. On the growing use and new applications. 2000 w. Yale Sci M—April, 1899. No. 27103 C.

Storage Batteries and Railway Power Stations. Robert McA. Lloyd. Points out some of the uses of a storage battery in connection with a typical station. Also discussions in New York and Chicago. 20800 w. Trans Am Inst of Elec Eng—Feb., 1899. No. 27101 D.

See Mechanical Engineering, Automobilmism.

Alternators.

Running Alternators in Parallel. Describes a method patented by G. Dettmar, of Linden, near Hanover, which aims at the removal of the difficulty of separating two parallel-connected machines without affecting the terminal potential of the one which is to remain on the 'bus bars. 1500 w. Elec Eng, Lond. March 31, 1899. No. 26998 A.

Canal Plant.

The Electric Plant of the Bourgogne Canal. (Installation Electrique au Canal de Bourgogne.) M. Galliot. A general description of the hydraulic electric power plant utilizing the power of the Saone to supply the Bourgogne canal with water. 4000 w. 4 plates. Aun des Ponts et Chausseés—4 Trimestre 1898. No. 27-226 E + F.

Central Station.

The Electric Lighting of Lynton and Lynmouth. J. H. Fooks Bale. Illustrates and describes one of the most interesting stations in Great Britain. 2000 w. Elec Eng, Lond—April 7, 1899. No. 27071 A.

Dynamos.

American Practice in Dynamo Construction. B. A. Behrend in *Elektrotechnische Zeitschrift*. Brief comparison of American and European practice relative to the construction of electrical machinery. 1400 w. Elec Eng, Lond—March 31, 1899. No. 26999 A.

On a Direct Current Dynamo Without Brushes. Albert Campbell. Concludes that commutation can be obtained without slipping contacts, that is, in absolutely fixed circuits, by means of alterations in resistance produced by magnetic, thermal or other means. Ill. 1000 w. Elec Rev, Lond—April 14, 1899. No. 27151 A.

English Practice.

Central Station Practice in Great Britain. H. Cuthbert Hall. A critical review of British practice with especial reference to the principles governing the reduction of cost. 3500 w. Engineering Magazine—May, 1899. No. 27282 B.

High Pressure.

Electricity at High Pressures. Elihu Thomson's lecture before the New York Elec. Soc. Abstract. Considers methods of attaining high voltages and describes a novel adaptation of the Planté rheostatic machine for the production of high electrical pressures. 1000 w. Elec Rev, N. Y.—April 5, 1899. No. 26938.

Isolated Station.

Extensive Isolated Electric Station. Brief illustrated description of the electric lighting plant of the Philadelphia City Hall. 600 w. Elec Rev, N. Y.—April 19, 1899. No. 27095.

Operating Dynamos.

Accidents Due to Operating Dynamos in Multiple. An explanation of the serious trouble that may be caused under stated conditions. Ill. 1800 w. Power—April, 1899. No. 26858.

Regulator.

The Sayers Pressure Regulator with Third Brush. (Ueber die Sayers'sche Spannungsregulierung mittels Dritter Bürste.) C. P. Feldman. An improved method of regulating voltage by the use of a third brush so arranged that its position relative to the main brushes may be shifted. The action is explained by numerous diagrams. 3500 w. Elektrotech Zeitschr—March 30, 1899. No. 27264 B.

Standards.

Standards for Direct Connected Generating Sets. J. B. Stanwood. Discusses the features that need standardization. 1500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27302 D.

Transformer Losses.

The Effect of Alternating Current Wave-Forms on Transformer Losses. Louis Duncan, Ferd B. Keidel, William L. Hodges and Edmund Frank. Diagrams and report of investigations. 1100 w. Elec Rev, N. Y.—April 26, 1899. No. 27310.

LIGHTING.**Arc Lamps.**

Triple-Connection System for 110 Volt Differential Arc Lamps. (Dreischal-tungssystem bei 110 V Gleichstrom mit A. E. G. Differential bogen lampen.) J. Zeidler. A description of the new triple connection system of the Allgemeine Elek-tricitäts-Gesellschaft. 2500 w. Elektro-

tech Zeitschr—March 30, 1899. No. 27-266 B.

Arcs.

Arcs Produced by Non-Symmetrical Currents between Metals and Carbon. (Sur les Arcs à Courants Alternatifs Dissymétriques entre Métaux et Charbons.) A. Blondel. A communication to the French Academy discussing the peculiar nature of the arcs produced between metal and carbon points; with data and diagrams from numerous experiments. 2000 w. Comptes Rendus—March 20, 1899. No. 27243 D.

The Hissing of the Electric Arc. Mrs. Ayrton. Read before the British Inst. of Elec. Engs. An interesting and important record of investigations and results thus far reached. 8300 w. Elec Eng, Lond—March 31, 1899. Serial. 1st part. No. 26997 A.

California.

The Monterey and Pacific Grove Light-ing Plant. Harry J. Bean. Illustrated description of this station as a type of the station most common throughout California. 1800 w. Jour of Elec—March, 1899. No. 27061.

Electric Plant.

See Marine Engineering.

Fountain.

The Illuminated Fountains at the Munich Exhibition. (Die Elektrische Leucht-fontaine auf der II Kraft-und Arbeits-maschinen ausstellung in München.) F. Uppenbom. With illustrations showing the arrangement of the illuminating apparatus, and the shifting of the colored glasses. 1500 w. Elektrotech Zeitschr—March 23, 1899. No. 27262 B.

Leith.

The Electric Lighting of Leith. Il-lustrated general description of this in-stallation. 1300 w. Elec Rev, Lond—April 14, 1899. No. 27154 A.

Nernst Lamp.

A One-and-One-Half Watt Lamp. Al-ton D. Adams. Considers the probable effect on arc and incandescent lamps, etc., if the claims of the Nernst lamp are sus-tained. 1000 w. Elec Wld & Elec Engr—April 1, 1899. No. 26890.

Street Lighting.

Electric Street Lighting. Albert Shei-ble. Read before the Chicago Elec. Assn. Reviews the causes that have affected street lighting in the past and recent changes due to electrical progress. 3500 w. Elec, N. Y.—April 5, 1899. No. 26-932.

Suburban Residences.

The Lighting of Country Residences. Illustrated description of a number of

small lighting plants, with and without storage battery adjuncts, and a discussion of the essential features of such installation. 2000 w. Eng Rec—April 1, 1899. No. 26880.

MEASUREMENT.

Efficiency.

The Determination of the Efficiency of Continuous Current Dynamos. (Sur la Determination du Rendement des Dynamos à Courant Continu.) C. Pierron. A discussion of the various methods of measuring dynamo efficiency, with especial reference to that of Swinburne, with examples of its application. 2500 w. L'Electricien—April 8, 1899. No. 27,270 B.

Loads.

Effect of Inequality of Voltage in Three-Phase Wattmeters in Measuring Motor Loads. August J. Bowie. Reports of six tests made to determine to what extent the readings would be affected. 700 w. Elec Wld & Elec Eng—April 22, 1899. No. 27117.

Losses.

The Separation of Hysteresis, Foucault Current and Friction Losses in Electrical Machines. (Die Trennung von Hysteresis, Foucault-Strom, und Reibungsverlusten in Elektrischen Maschinen.) G. Dettmar. An elaborate discussion of the method of separating these losses, which must be measured together and subsequently analysed. Two articles. 6000 w. Elektrotech Zeitschr—March 16, 23, 1899. No. 27261, each B.

Measuring Instruments.

The Construction of a Voltmeter and Ammeter Suitable for a Small Switchboard. Nevil Monroe Hopkins. Directions for making simple forms of indicating instruments, and instruction for their calibration and care. Ill. 5700 w. Sci Am Sup—April 15, 1899. No. 27056.

Meter.

The Vulcan Electric Meter. (Compteur d'Energie Electrique, Type Vulcan.) M. Aliamet. An improved meter of the so-called "motor" type, consisting of a motor, a braking device, and a totaliser. 2500 w. L'Electricien—April 1, 1899. No. 27269 B.

POWER APPLICATIONS.

Coal Cutters.

See Mining and Metallurgy, Coal.

Electric Brakes.

See Mechanical Engineering, Automobilmism.

Electric Power.

See Mining and Metallurgy, Mining.

Fan Motors.

Fan Motor Selection. Alton D. Adams. Discusses the relation between speed and capacity. Ill. 1800 w. Heat & Ven—April, 1899. Serial. 1st part. No. 27184.

Modern Plants.

The Electrical Transmission and Application of Power. Illustrates and describes three plants in the United States, each typical of a certain class of work, and of the industrial application by the same medium. 5500 w. Power—April, 1899. No. 26857.

Motive Power.

The Use of Electricity as a Motive Power in Modern Steel Works and Blast Furnaces. Andrew Ellicott Maccoun. Notes some of the uses to which motors are applied, and their advantages. 1100 w. Elec Wld & Elec Engr—April 15, 1899. No. 27051.

Polyphase.

Electric Driving with Polyphase Currents. (Elektrischer Einzelantrieb mit Drehstrom.) O. Lasche. With especial reference to the application of polyphase currents to the independent driving of machine tools as installed at the Allgemeine Elektrizitäts Gesellschaft in Berlin; very fully illustrated. 5000 w. Zeitschr d Ver Deutscher Ing—March 18, 1899. No. 27201 D.

Polyphase Motors of Great Starting Movement and Capacity. (Ueber Drehstrommotoren mit Grossem Anzugsmomente und Grosser Beanspruchungsfähigkeit.) T. Marcher. A mathematical analysis of the conditions involved, and graphical representations, giving curves for the various elements. 4500 w. Elektrotech Zeitschr—March 30, 1899. No. 27265 B.

Three-Phase.

See Street and Electric Tramways.

MISCELLANY.

Cost of Electricity.

Data on Electric Power Generation, Glasgow. Reviews a report by H. F. Parshall on the expense of generating current for the Glasgow street railways; a single central station with three phase distribution to transformer stations is recommended. 1300 w. Eng Rec—April 22, 1899. No. 27136.

Electrolysis.

The Problem of Electrolysis. An editorial on the importance of fixing the responsibility of repairs to water mains which are injured by electric currents from street railways. 1600 w. Eng Rec—April 22, 1899. No. 27127.

GAS ENGINEERING

Acetylene.

Acetylene and its Applications. (L'Acétylène et ses Applications.) M. E. Hubon. An extended review of the present status of lighting by acetylene, including descriptions of generators, burners and other appliances. 10,000 w. Soc Ing Civ de France—Feb., 1899. No. 27237 G.

Calcium Carbide and Acetylene. Part first reviews the history of the manufacture of calcium carbide. 1600 w. Ind & Ir—April 14, 1899. Serial. 1st part. No. 27148 A.

The Explosiveness of Acetylene when Mixed with Inert Gases. (Sur l'Aptitude de l'Acétylène Mélange à des Gaz Inertes.) MM. Berthelot and Vieille. A very full account of the further researches of these distinguished investigators, showing the influence of the composition of the diluting gas. An important paper. 4000 w. Comptes Rendus—March 27, 1899. No. 27244 D.

The Fire Underwriters' Rules for Safe Introduction of Acetylene Gas Generators. Charles A. Hexamer. A copy of the rules, with introductory remarks. 1800 w. Jour Fr Inst—April, 1899. No. 26953 D.

The Real Value of Acetylene as an Illuminant. Gives a comparison of different illuminants as regards cost, illuminating power, and hygienic effect. 3300 w. Engr, Lond—March 31, 1899. No. 26971 A.

Distribution.

Distribution Records; Their Uses and Preservation. J. A. Mayers. Read before the Ohio Gas Lgt. Assn. Describes methods of keeping records. 5700 w. Am Gas Lgt Jour—April 3, 1899. No. 26905.

Edinburgh.

New Gas Works at Edinburgh. A review of Mr. Herring's report and the main features of construction as recommended for the new works which will replace a number of old establishments. 4400 w. Engr, Lond—March 24, 1899. No. 26872 A.

Forms.

Some Forms and Their Uses. Walton Forstall. Forms from various sources for the preservation of information connected with the gas industry. 4000 w. Am Gas Lgt Jour—April 24, 1899. No. 27140.

Fuel Gas.

Industrial Gas. Frank H. Bates. Part first considers methods of gas analysis. 6000 w. Jour of Elec—April, 1899. Serial. 1st part. No. 27179.

The Riché Generator of Gas from Wood. (Le Gazogène au Bois "Riché.") MM. Manant and Roman. A very full account of the Riché process, with sections and details of generators, and a discussion of its industrial applications. 10,000 w. Soc Ing Civ de France—Feb., 1899. No. 27239 G.

Gas Exhausters.

Gas Exhausters and Gas Exhausting Plant. R. Hargraves. Abstract of paper read at meeting of the Manchester, Eng., Assn. of Engineers. Reviews the introduction and development of exhausters, the engines usually used for driving, and shows that the best plant for exhausting coal gas was far behind the present practice. Discussion. 4000 w. Jour Gas Lgt—March 28, 1899. No. 26983 A.

Hydrocarbons.

The Condensable Hydrocarbons in Coal Gas. Wilfrid Irwin. Read before the Manchester Section of the Soc. of Chem. Ind. Considers the effect of high temperatures, vapor tensions, and the superiority of benzine for enrichment. 1800 w. Gas Wld—March 25, 1899. No. 26869 A.

Incandescence.

Experiences with the Incandescent Gas Light. Norton H. Humphreys. On the value of this invention to the gas industry and the general public, and some of the reasons why it has not been more cordially welcomed are considered in the present number. 2800 w. Jour Gas Lgt—April 4, 1899. Serial. 1st part. No. 27054 A.

Inclined Retorts.

An Experience with Inclined Retorts. Esslingen, Germany. Ernest Kohler. Translated from the *Journal fur Gasbeleuchtung*. An account of the benches of inclined retorts erected in 1897. 1500 w. Am Gas Lgt Jour—April 17, 1899. No. 27063.

Street Lighting.

Welsbach Street Lighting. J. W. R. Cline. Read at meeting of the Ohio Gas Light Assn. Calls attention to some of the difficulties met, and the manner in which they were overcome, noting features of interest in the apparatus. Discussion. 7000 w. Am Gas Lgt Jour—April 10, 1899. No. 26984.

Welsbach.

The Rawson Patents Sustained. The decision of Judge Shipman in the case of the Welsbach Light Co. vs. Apollo Incandescent Light Co. et al. 2300 w. Pro Age—April 15, 1899. No. 27031.

MARINE AND NAVAL ENGINEERING

Amphitrite.

The Steam Trials of H. M. S. "Amphitrite." This article was written when only one trial had been completed, the 3600 indicated horse-power trial which is reported very satisfactory. 1300 w. Engng—April 14, 1899. No. 27164 A.

Ballasting.

The Ballasting of Steamers. Editorial discussion of this subject and the need that something be done to remedy the trouble and lessen the casualties due to this cause. 1700 w. Engr, Lond—March 24, 1899. No. 26874 A.

British Shipping.

British Shipping and Ship-building. The large business in ship-building in British yards during the past year and the promise of increase the coming year, and matters of special interest in connection with the mercantile marine. 2800 w. U. S. Con Repts, No. 402—April 17, 1899. No. 27064 D.

Cable Ship.

The United States Cable Ship "Hooker." Brief description, with illustration, of the ship that will lay cables between the Philippine Islands. 700 w. Elec Rev, N. Y.—April 26, 1899. No. 27309.

Construction.

The Means and Aim of Marine Construction in Germany at the Beginning of the Twentieth Century. (Ueber Mittel und Ziele des Deutschen Wasserbaues am Beginn des XX Jahrhunderts.) J. F. Bubendy. A review of marine construction up to the present time, including harbours, channels, docks, canals, etc., and a discussion of future needs in view of the increasing size of vessels. Three articles. 6000 w. Deutsche Banzeitung—March 25, 31, April 5, 1899. No. 27272, each B.

Cruiser.

A Model Cruiser. Illustrates and describes the Tigress model cruiser, constructed by Charles L. Palmer, Albany. N. Y. 1300 w. Engr, Lond—April 14, 1899. No. 27172 A.

H. M. S. Spartiate. Illustrated description, with drawings of the engines and boilers. 1800 w. Engr, Lond—April 7, 1899. No. 27085 A.

The Japanese Protected Cruiser Kasagi. Illustrated description of the vessel and her armament. 1800 w. Engr, Lond—March 31, 1899. No. 26973 A.

Disasters.

Marine Breakdowns and Losses. A narrative of the mishaps which befell some well-known liners. 2000 w. Marine Engng—April, 1899. No. 26888 C.

Dock.

Great Floating Dock. Plans and information concerning a structure recently contracted for by the United States, which will be the largest floating dock in the world. 800 w. Marine Rev—April 20, 1899. No. 27143.

Efficiency.

Efficiency of the Twin-Screw Steam Yacht Sovereign. John D. Hackstaff, Warren H. Miller, Waldo G. Lunger. Graduating thesis discussing the application of Rankine's Theory of the Mathematical Action of Screw Propellers in determining the efficiency of this yacht and of distribution and dissipation of the power given out by her engines. 1500 w. Stevens Ind—April, 1899. Serial, 1st part. No. 27124 D.

Electric Plant.

Electricity on American Vessels. J. McGhie. Part first gives an illustrated description of the equipment of the "Priscilla," a passenger and freight steamer plying on Long Island Sound. 1300 w. Elec Eng, Lond—April 7, 1899. Serial, 1st part. No. 27072 A.

French Steamer.

The French Passenger Steamer "Laos." An account of the Compagnie des Messageries Maritimes, with description of this new high-class vessel. Ill. 1700 w. Engng—March 31, 1899. Serial, 1st part. No. 26981 A.

Ice Breaking Steamer.

The Ice-Breaking Steamer "Ermack." Information respecting this interesting vessel built for the Russian government. Ill. 4200 w. Engng—March 31, 1899. No. 26980 A.

Lake Steamer.

Saloon Steamboat "Genève," on the Lake of Geneva. (Das Salonboot "Genève." auf dem Genfer see.) An illustrated description of this fine new Swiss lake steamer, built by Sulzer Bros., of Winterthur. 1000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 1, 1899. No. 27206 D.

Mercantile Marine.

The French Marine. Editorial discussion of the new strategy of the Minister of the Marine, and of the debate on the estimates in the Chamber of Deputies. 3000 w. Engr, Lond—March 31, 1899. No. 26975 A.

Naval Boilers.

See Mechanical Engineering, Steam Engineering.

Navies.

The Naval Situation. H. W. Wilson. Discusses the position of the seven great Powers, the growth of navies, new factors in naval war, and the standing of Great Britain. 7000 w. Nineteenth Cent—April, 1899. No. 27091 D.

Oil.

The Action of Oil on Waves at Sea. Notes on the calming action of oil in rough weather. 1200 w. Engr, Lond—April 14, 1899. No. 27171 A.

Repair Ship.

The Work of the U. S. S. Vulcan. Facts given by William S. Aldrich in a lecture before the junior members of the A. S. M. E. on March 7, relative to the work while the ship was with Sampson's fleet. 2000 w. Mach, N. Y.—April, 1899. No. 26845.

Resistance.

The Resistance of Transverse Waves to the Progress of Vessels. (De la Résistance à l'Avancement des Bateaux et des Ondes Transversales.) M. F. Chandy. A mathematical discussion in connection with models for use in tank trials, showing the influence of the dimensions of the tank upon the results. 3500 w. Soc Ing Civ de France—Feb., 1899. No. 27236 G.

Riveters.

See Mechanical Engineering, Machine Works.

Shafts.

See Mechanical Engineering, Machine Works.

Ship Yard.

A Great Ship Yard. Full illustrated description of the many departments of the Newport News yard, with brief account of the founder, and of its rapid development. 12000 w. Marine Rev—March 30, 1899. No. 26856.

Stability.

Calculating Cross-Curves of Stability. C. F. Munday. Read before the Inst. of Naval Archts. On the advantages of using Tchebycheff's rule in association with the integrator to obtain cross-curves of stability. 1200 w. Engng—April 14, 1899. No. 27167 A.

Steering.

An Account of the Attempts to Introduce Compressed Air for Steering Vessels. J. C. Walcott. Gives the history of attempts in this line during the last fifteen years, stating the benefits, and the improvements. 700 w. Compressed Air—April, 1899. No. 26987.

Stresses.

Stresses on Ships. J. Bruhn. Paper read before the Inst. of Naval Archt's, England, on the "Stresses at the Discon-

tinuities in a Ship's Structure." Deals with the forces acting on the vessel as a whole, and not with those due to local forces. 6000 w. Engng—March 31, 1899. No. 26982 A.

Submarine Boats.

French Submarine Torpedo Boats. Illustrates and describes the vessels built by Gustave Zédé, and their trials. 1800 w. Sci Am—April 8, 1899. No. 26933.

Submarine Mines.

Electric Fuses and Exploders for Submarine Mines. J. Wright. Describes the principal fuses and exploders employed in the submarine mines of the American navy during the last few years, with their behavior under trial. 2500 w. Ind & East Engr—March, 1899. Serial. 1st part. No. 27158 D.

Tank Steamer.

S. S. Atlas, New Oil Tank Steamer for the Standard Oil Co. Plans, photograph and description. 1600 w. Marine Engng—April, 1899. No. 26887 C.

Tow Boats.

The Tow-Boats "Infatigable" and "Taillebourg." (Les Remorqueurs "Infatigable" et "Taillebourg.") A full description of two powerful tow-boats recently acquired by the French government from Holland, with photographs and a plate of engine details. 2500 w. 1 plate. Génie Civil—April 8, 1899. No. 27214 D.

Trials.

Some Steam Trials of Danish Ships. A. Rasmussen. Read before the British Inst. of Nav. Engs. Report of trials made to determine the elements of propulsion of ships and torpedo boats under various circumstances. 1600 w. Engng.—March 24, 1899. No. 26868 A.

Tug.

Most Powerful Tug. Illustration with description of the new towing steamer, R. W. Wilmot, which exceeds in engine capacity any other similar craft in American waters. 1400 w. Marine Rev—April 20, 1899. No. 27142.

Warships.

The Logical Arrangement of the Motive Power of Warships. George W. Melville. Points out some of the advantages due to the use of three propelling engines as shown in the U. S. cruisers Columbia and Minneapolis, and the methods of arrangement as thus far investigated. Also considers the disadvantages. 5500 w. Engr, Lond—March 24, 1899. Serial. 1st part. No. 26873 A.

The Monitor, the Battleship, the Cruiser, and the Destroyer. G. W. Dickie.

Mr. Dickie's concluding paper discusses the function of the cruiser, and gives a very careful analysis of the qualities necessary for an efficient destroyer, with a design for a proposed sea-going torpedo boat destroyer. 3000 w. *Engineering Magazine*—May, 1899. No. 27280 B.

Yachts.

Steam Power of Small Yachts. William Burlingham. Rules for calculating the displacement, horse-power, speed and the necessary points about the propeller for small boats of medium speed. 2000 w. *Mach*, N. Y.—April, 1899. No. 26846.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Accumulators.

The Crowds Accumulator. Illustrates and describes a cell which has been claimed to be the most suitable yet designed for automobile purposes. 1500 w. *Automotor Jour*—April, 1899. No. 27324 A.

Differential Gear.

The De Dion and Bouton Differential Gear. Reviews what is known of this invention and gives illustrated description of the gear named which is claimed to be the best form of differential yet devised. 1000 w. *Automotor Jour*—April, 1899. No. 27321 A.

Electric Brakes.

An Independent Motor to Utilize the Brake Energy. Merrill E. Clark. Abstract of a lecture describing a system of independent motor and a means of utilizing the brake energy in connection with street railways and other traction. Ill. 700 w. *Compressed Air*—April, 1899. No. 26986.

The Value of Electric Brakes as Recuperating Devices for Automobiles. F. B. Booth. Considers that the value rests wholly with the conditions under which the vehicle is used, and that it is not likely to be used on vehicles built for city service. 1400 w. *Elec Wld & Elec Engr*—April 8, 1899. No. 26968.

French Law.

The Law Relating to Motor Vehicles in France. Rules for traffic on the public roads with editorial. 3000 w. *Automotor Jour*—April, 1899. No. 27327 A.

Motor Carriages.

Joel Electric Motor Carriage. Illustrates and describes a new form of motor carriage said to run very smoothly with little vibration. 1700 w. *Elec Rev*, Lond—April 7, 1899. No. 27075 A.

Motor Carriages and Street Paving. Thomas Conyngton. On the progress and outlook for these vehicles and the effect on the life in cities that would result from their general use. 1700 w. *Munic Engng*—April, 1899. No. 26893 C.

Steam Driven Road Carriages. Wil-

liam H. Harrison. Describes a proposed construction of a steam carriage weighing about 1500 pounds with riders. 2200 w. *Am Mach*—April 6, 1899. No. 26942.

Moto-Wheel.

The Simms Patent "Motor Wheel." Illustrated detailed description. 900 w. *Automotor Jour*—April, 1899. No. 27323 A.

Omnibus.

The Serpollet Steam Omnibus. Illustrates and describes a vehicle built to accommodate 14 passengers, and carry 1100 lbs. of baggage. 600 w. *Automotor Jour*—April, 1899. No. 27325 A.

Tricycle.

Automobile Tricycle with Variable Speed Gear. (Tricycle Automobile à Vitesse Variable.) Ch. Gruet. Describing a practical form of variable gear to be used in connection with a petroleum motor, enabling a smaller motor to be used, and permitting low gears to be obtained for ascending grades. 2000 w. *Revue Technique*—April 10, 1899. No. 27220 D.

Tyres.

General Notes Respecting India Rubber Tyres for Carriages and Moto-Vehicles. Illustrates and describes the chief existing types of tyres, gives suggestions relating to the choice of tyres, and advice as to their maintenance and preservation. 2400 w. *Automotor Jour*—April, 1899. No. 27326 A.

Rolling Resistance to India Rubber Tyres. H. E. Wimperis. The present article deals with the elasticity of the air in pneumatic tyres, and discusses how far it is perfect or imperfect. 900 w. *Automotor Jour*—April, 1899. Serial. 1st part. No. 27322 A.

The General Relation of Tires to Motor Vehicle Construction. Considers the relation of the parts, and the effect on the wear of tires. 1000 w. *Horseless Age*—April 5, 1899. No. 26931.

See also Materials.

Vehicle Motors.

Some Thermo-Dynamics of Vehicle Motors. Hudson Maxim. Data on relative efficiencies of various motor fluids in their application to vehicle propulsion.

7300 w. Horseless Age—April 5, 1899. No. 26930.

HYDRAULICS.

Deep Wells.

Experiences with Deep-Well Pump Rods. G. W. Bissell. Describes experiences in connection with the deep well which constitutes the principal water supply of the Iowa State College. 1000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27194 D.

Fire Hydrants.

Experiments on Various Types of Fire Hydrants. Charles L. Newcomb. A report of tests aiming to make a complete investigation of the fire hydrants now commonly used, giving tabulated results. Ill. 15000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27190 D.

Power Distribution.

Hydraulic Transmission and Distribution of Power. E. B. Ellington. The first portion of a presentation of the claims of high-pressure hydraulic transmission to consideration, being devoted to questions of the cost of generation and transmission, and to be followed by details of application. 3000 w. Engineering Magazine—May, 1899. No. 27284 B.

Pumps.

A Gasoline Pumping Plant for the Water-Works of Toms River, N. J. Information concerning this installation. Ill. 700 w. Eng News—March 30, 1899. No. 26861.

An Air-Chamber Charging Pump. Walter Ferris. On the operation, uses and usefulness of the air-pump. Ill. 1200 w. Am Mach—March 30, 1899. No. 26852.

Repairing a Deep-Well Pump. Describes a mishap that occurred in lowering a pump and the means taken to set matters right. 1700 w. Engr, Lond—March 31, 1899. No. 26979 A.

Propeller Pumps. Describes an apparatus for raising water in wells by means of horizontal wheels working like the propellers of a steamship. 1000 w. Eng Rec—April 22, 1899. No. 27131.

MACHINE WORKS AND FOUNDRIES.

Boring Cylinders.

Boring Cylinders for Motor Vehicles. Robert I. Clegg. Considers tools, expedients and methods used. 1600 w. Horseless Age—April 12, 1899. No. 27016.

Car Wheels.

The Manufacture of Car Wheels. G. R. Henderson. Points about the manufacture of car wheels which have been observed by the writer. The lessons learned

from chemical analysis and physical tests. 3500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27187 D.

Casting.

Casting a Power-Press Frame. R. H. Palmer. Sketches, with description of a casting weighing some 4,000 lbs. 1500 w. Foundry—April, 1899. No. 27120.

Chemistry.

Dividing the Authority. E. C. Wheeler. On a chemist's position in a foundry. 1800 w. Foundry—April, 1899. No. 27121.

Dies.

Die Construction. George B. Painter. Description and drawing showing a construction useful in duplicating shapes. 1500 w. Am Mach—April 6, 1899. No. 26941.

Drafting.

Drafting Methods of the Newport News Shipbuilding & Dry-Dock Co. An account of the methods adopted in carrying on the designing and estimating work. 1500 w. Eng Rec—April 15, 1899. No. 27035.

Elevators.

Elevators. Charles R. Pratt. Considers the requirements of an elevator, and describes the means used to meet them. Ill. 15,900 w. Trans Am Soc of Mech Engs—May, 1899. No. 27191 D.

The Plunger Elevator. George J. Alden. Illustrates and describes this elevator and presents its merits as an appliance for modern office buildings. 5500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27186 D.

Fall of an Elevator in Chicago. An account of the accident, and substance of the inspector's report of the investigation. 500 w. Eng News—April 27, 1899. No. 27340.

The Elevator Equipment of the Ivins Syndicate Building, Park Row, New York. Describes the solution of the problem of furnishing rapid and safe transit to and from the various floors of the highest office building in the world. Also editorial comparison of electric and hydraulic elevators for high buildings. Ill. 5800 w. Eng News—April 27, 1899. No. 27341.

Flanges.

Experiments on Flange Joints. (Versuche mit Flanschenverbindungen.) C. Bach. A very fully illustrated account of tests made upon the strength of bolted flange-joints on pipes, valves, etc. Accurate measurements of the deformation under various pressures were made, and much valuable information deduced. Two articles. 7500 w. Zeitschr d Ver Deutscher Ing—March 25, April 1, 1899. No. 27204 each D.

Pipe Flanges and Their Bolts. A. F. Nagle. Analyzes the forces at work upon a flange joint and recommends changes that aim to relieve the material of strains. 2000 w. Trans Am Soc of Mech Engs—May, 1899. No. 27188 D.

Fly-Wheels.

Rolling Mill Fly-Wheels. John Fritz. A review of the progress made in the construction of fly-wheels. Ill. 1500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27196 D.

Foundry.

New Foundry of the General Electric Co. Illustrated description of the building known as "No. 83," of the Schenectady plant. 1800 w. Ir Age—April 6, 1899. No. 26936.

The New Foundry of the General Electric Co. Illustrated description of an iron foundry measuring 505 x 140 ft., with a 120 x 103 ft. wing. Explains the construction of oven doors swinging on ball-bearings, and core carriages having pneumatic movement and automatic doors. 1200 w. Eng Rec—April 15, 1899. No. 27038.

Foundry Heating.

Heating the Foundry of the General Electric Co. An illustrated account of the plant for heating this new building. 1400 w. Ir Age—April 27, 1899. No. 27314.

Gears.

A New System of Bevel Gear Making. Illustrates and describes some late machines designed by O. J. Beale, of the Brown & Sharpe Manufacturing Co. 1100 w. Am Mach—April 6, 1899. No. 26939.

Lathes.

A Large Pattern Lathe. John Randol. Illustrates and describes a heavy pattern lathe at the iron works of Struthers, Wells & Co., Warren, Pa. 1300 w. Am Mach—March 30, 1899. No. 26853.

Machine Construction.

The Present Status of Machine Construction. (Ueber die Heutige Bedeutung des Maschinenbaues.) P. Zwianer. An address delivered at the fiftieth anniversary of the Austrian Society of Engineers, reviewing the development of mechanical engineering in Europe during the latter half of the century. 5000 w. Zeitschr d Oosten Ing u Arch Ver—April 7, 1899. No. 27209 B.

Molding.

Making a Roller Path in Loam. James A. Murphy. Illustrated description of the making of a large casting. 1900 w. Foundry—April, 1899. No. 27119.

Molding a Wheel Segment. R. H. Palmer. Illustrated description of the molding of a segment of a driving-wheel of a

large Corliss engine. 2200 w. Am Mach—April 27, 1899. No. 27317.

Ornamental Iron.

The Use, Design and Manufacture of Iron in Ornament. Chester B. Albree. Abstract of a paper read at the monthly meeting of the Engs. Soc. of W. Penna. Discusses the ancient and modern work and the need of a better understanding on the part of architects and designers of the processes of manufacture. 900 w. Ir Trd Rev—March 30, 1899. No. 26842.

Preston Works.

New Electric Tramcar and Railway Carriage Works at Preston. A description of the various departments in the order in which they receive the materials. 1700 w. Engr, Lond—March 31, 1899. No. 26977 A.

Repair Shops.

Power Station and Repair Shops of the Cleveland Electric Railway Co. Illustrated detailed description of a plant having many interesting features. 4000 w. St Ry Jour—April, 1899. No. 26919 D.

Rifles.

Manufacture of Krag-Jorgensen Rifles at the Springfield Armory. Part first gives an illustrated description of the famous Springfield Armory in which all types of small arms for the United States have been made since the Revolution. 2300 w. Sci Am—April 29, 1899. Serial. 1st part. No. 27319.

Riveters.

Portable Pneumatic Riveters in Shipbuilding. W. J. Babcock. Read at meeting of the Inst. of Naval Archts. Describes methods used in the yards of the Chicago Shipbuilding Co. 3000 w. Engr, Lond—March 31, 1899. No. 26978 A.

Screw-Threads.

The Unification of Screw Threads. (Unification des Filetages.) The full report of the International Congress at Zurich for the unification of metric screw-thread systems, with the text of the discussions, and a bibliography of the subject. 10,000 w. Bull de la Soc d'Encour—March, 1899. No. 27231 G.

Shafts.

Another Diagram for the Design of Shafts. C. L. Griffin. Diagram with explanation of its use. 500 w. Am Mach—April 6, 1899. No. 26940.

Notes on the Manufacture of Shafting for Screw Steamers with Some Causes of Defects and Failures. Edward Catmore Chaston. Abstract of a paper read before the North-East Coast Inst. of Engs. and Shipbuilders, with editorial comment. The writer aims to show that about half of the defects and failures are due to preventable causes. 4800 w. Engs Gaz—April, 1899. No. 26993 A.

Remarks on the Increasing Frequency of Failure of Propeller Shafts. Frank Caws. Read before the North-East Coast Inst. of Engs. and Shipbuilders. Alludes to the possibility of adopting larger and hollow shafting, and shows that rules for the diameter of a steamer's shafting should not be based only on the power of the engines, but also on the power of the ship's displacement at the light draught. 2700 w. Ind & Ir—March 30, 1899. No. 27002 A.

Speed Diagram.

A Pulley Speed-Ratio Diagram. Gives a diagram and method of using, of service in all problems relating to the diameter and speed of wheels, rims, pulleys, etc. 150 w. Mech Wld—April 7, 1899. No. 27067 A.

Tools.

English and American Machine Tools. T. Wood Meakin. Points in which, in the opinion of an English engineer, American tools might be better adapted to the needs of English shops. 2400 w. Mod Mach—April, 1899. No. 26895.

Machine Tools. J. Richards. Part first consists of general remarks introductory to a review and criticism of the practice. 2200 w. Am Mach—April 27, 1899. No. 27316.

Modern Turret Lathes and Screw Machines. Joseph Shepherd. Abstract of a paper and interesting discussion presented at meeting of Glasgow Assn. of Students of the Inst. of Civ. Engs. Deals considerably with the superiority of foreign made tools, describing some of them, and showing the great saving by their use. 5000 w. Engr, Lond—March 24, 1899. No. 26875 A.

Some Amateurs' Machine Tools in England. F. J. M. Illustrates and describes tools built for the use of amateur mechanics by the firm of G. Birch & Co., England. 2100 w. Am Mach—April 27, 1899. No. 27315.

Transport.

Means of Transport in and About Works. Jenner G. Marshall. From a paper read before the South Staffordshire Inst. of Iron & Steel Works Managers. Considers fixed means, including canal and dock basins, railways, cranes, elevators, conveyors, capstans and rope-haulage; and movable, including carts, trolleys, sliding skids, ways and rollers, traction engines, etc. 3300 w. Col Guard—March 30, 1899. No. 27005 A.

Westinghouse.

The Westinghouse Electric Works at Pittsburg. An illustrated detailed description. 2500 w. Engng—March 24, 1899. Serial. 1st part. No. 26866 A.

Wood-Working Machinery.

The Development of Woodworking

Machinery. John Richards. Devoted to a comparison between English and American wood planing machines with many handsome illustrations of characteristic types. 3500 w. Engineering Magazine—May, 1899. No. 27286 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. The fifth paper of the series is devoted to the growth of competition and its influence upon the development of trade, showing the action of national characteristics and methods. 3500 w. Engineering Magazine—May, 1899. No. 27287 B.

MATERIALS OF CONSTRUCTION.

See also Civil Engineering, Materials.

Elastic Limit.

The Elastic Limit and Yield Point of Steel. Explains the difference between the elastic limit and the yield point in making tensile tests, and shows the importance of an accurate determination. 1000 w. Prac Engr—April, 14, 1899. No. 27145 A.

Erosion.

The Erosion of the Bore of Artillery. (L'Erosion de l'Interieur des Canons.) A discussion of the probable causes of bore-erosion, taking into account the physical constitution of the steel as revealed by metallography. 1200 w. Revue Technique—April 10, 1899. No. 27219 D.

Gun Explosion.

Cause of the Recent Explosion of the Ten-Inch Gun at Sandy Hook Explained. Hudson Maxim. An explanation by one of the inventors of the smokeless powder used. Ill. 2000 w. Sci Am—April 8, 1899. No. 26934.

Explosion of a Gun at Sandy Hook, New York Harbor. Discusses the cause of the accident. 1500 w. Engng—April 14, 1899. No. 27165 A.

Metallography.

Microscopic Studies upon Deeply-Etched Sections of Iron. (Mikroskopische Untersuchungen an Tiefgeätzten Eisen-schlissen.) E. Heyn. An important contribution to the study of the physical character of iron, with photogravure reproductions of many deeply etched sections. 7500 w. 6 plates. Mitt aus den Kgl Tech Versuchsaustalt—Part VI, 1898. No. 27257 G.

Springs.

Safe Loads for Helical Springs. Robert A. Bruce. The discussion considers the cylindrical helical spring. Ill. 2000 w. Am Mach—April 20, 1899. Serial. 1st part. No. 27096.

Steel.

See Mining and Metallurgy, Iron & Steel.

Stresses.

Repeated Stresses. Jerome Sondericker. Also discussion by James E. Howard. Presents tests and gives a general discussion of the results obtained up to date. Investigations are given for the determination of the elastic changes resulting from the repeated stresses, and the influence of such changes in causing fracture; and the influence of form, flaws, and the local condition generally in causing fracture. Ill. 6000 w. Tech Quar—March, 1899. No. 27020 E.

Tests.

Second Series of A. F. A. Tests. Gives the results of transverse, tensile and compression tests of bars. 1000 w. Ir Trd Rev.—April 13, 1899. No. 27033.

Tyres.

India-Rubber Carriage Tyres. Editorial discussing the growing use of these tyres, the cost, quality of rubber, and points connected with the raw material. 2200 w. Engng—April 7, 1899. No. 27077 A.

POWER AND TRANSMISSION.**Belts.**

Relation Between the Initial Tension and Power Transmitted by a Belt. F. L. Emory. Formula for finding the initial tension on a belt when still, in order to transmit or develop a certain work when running, with graphical illustrations. 500 w. Trans Am Soc of Mech Engs—May, 1899. No. 27193 D.

Rules for Determining the Horse-Power of Belts. Abstract of a paper read by John J. Flather before the North-West Ry. Club. A practical discussion of the belting problem, with rules and tables for making all necessary calculations. 2500 w. Mach, N. Y.—April, 1899. No. 26847.

Compressed Air.

Air Compression. Robert Peele. Illustrates and describes the structure and mode of action of the five classes commonly used. 2400 w. Mines & Min—April, 1899. No. 26918 C.

Compressed Air Enterprises. George C. Densmore, in *Municipal and Railway Record*. Reviews various applications especially as a motive power for railway traction, noting the undertaking on the 28th and 29th street railway in New York. 2500 w. Compressed Air—April, 1899. No. 26988.

Compressed Air Motors in Boston. Gives Mayor Quincy's views on the use of compressed air for a motive power, and states some advantages of liquid fuel over

compressed air. 1700 w. Bos Jour of Com—April 1, 1899. No. 26909.

Compressing Air to Produce a Dry Atmosphere. Frank Richards. In response to an inquiry where dry air is needed in the manufacture of a chemical, the writer explains how to obtain such an atmosphere. 1300 w. Am Mach—April 20, 1899. No. 27097.

Economy of Compressed Air Power Transmission. William O. Webber. Considers the possibilities of this method of storing and converting energy. 1200 w. Am Mach—April 13, 1899. No. 27010.

Pneumatic Equipment for Boiler Shops. E. A. Rix, in the *Boiler Maker*. On the numerous applications of pneumatic tools to work in these shops, and the economy secured by their use. 2000 w. Ir Trd Rev—April 20, 1899. No. 27106.

Pneumatic Tube Delivery System at the Waldorf-Astoria Hotel. Illustrated description of a system handling often 10,000 letters, cards, etc., a day, which has never had a breakdown during the eighteen months it has been in operation. 1200 w. Sci Am—April 15, 1899. No. 27014.

The Pneumatic Mail Tube System. J. Foster Symes. Gives the history of the progress of this system in different countries, describing the New York system for the transmission of mail. 2100 w. Yale Sci M—April, 1899. No. 27105 C.

Fuel Gas.

See Gas Engineering.

Office Building.

See Architectural Engineering, Construction.

Power Cost.

The cost of the Generation of Power. (Kosten der Krafterzeugung.) N. Holz. A supplement to Eberle's recent work on the same subject, with diagrams showing the cost of power generated by a variety of heat motors, as compared with water power. 2500 w. Zeitschr d Ver Deutscher Ing—March 18, 1899. No. 27202 D.

Power Multiplying.

Two Power Multiplying Engines. An account of an engine recently on exhibition at the Liberty Bldg., New York; also of another being exploited in Philadelphia, showing the absurdity of the claims. 3500 w. Eng News—April 6, 1899. No. 26946.

Power Plant.

A Factory Power Plant. Description of a Newark, N. J., plant which is entirely independent of outside companies or the municipality for its water supply, electricity, fire protection and power. 1400 w. Eng Rec—April 8, 1899. No. 26964.

The Power Plant of a University. Edward A. Darling. Describes the design and installation of the plant, showing in

outline the building equipment it serves, and its operation. Ill. 15500 w. Trans Am Soc of Mech Eng—May, 1899. No. 27199 D.

Steering.

See Marine and Naval Engineering.

SPECIAL MOTORS.

Gas Engines.

A Gas Engine Drive in a Machine Shop. A. R. Bellamy. Extract from a paper read before the Manchester, (Eng.) Assn. of Eng. An account of the installation and cost of operation of a plant. 2300 w. Am Mach—April 13, 1899. No. 27011.

Double Acting Gas Engine. (Moteur à Gaz à Double Effet.) An illustrated description of the Letombe gas engine in which the regulation is effected by a variable compression controlled by the governor. Indicator diagrams, and a plate of working details are given. 2000 w. I plate. Génie Civil—April 1, 1899. No. 27213 D.

Investigations of Gas Engines, with Especial Reference to the Influence of the Compression. (Untersuchungen am Gasmotor, insbesondere über den Einfluss der Kompression.) E. Meyer. A mathematical discussion of data obtained from numerous tests, with numerous diagrams, made at the Technical High School at Hanover. Three articles, 10-000 w. Zeischr d Ver Deutscher Ing—March 18, 25, April 1, 1899. No. 27200 each D.

Gas and Gasoline Engines. The first of a series of articles aiming to give accurate information as to the use of such engines. Part first deals with heat as shown in the changing of volumes of gases. 2000 w. Am Mfr & Ir Wld—April 21, 1899. Serial. 1st part. No. 27141.

Gas Engines. J. Emerson Dowson. Abstract of a paper read before the Cleveland Inst. of Eng., Middlesborough, Eng. On the progress during recent years, its causes, the use of generator gas and its cost. 2600 w. Ir Trd Rev—April 20, 1899. No. 27107.

Gasoline Engines.

Economy in Small Power. A comparison between steam and gasoline engines from the user's standpoint. 2800 w. Ir Age—April 6, 1899. No. 26937.

Internal Combustion.

The Use, Care and Repair of Internal Combustion Motors. James W. Tygard. Calls attention to the fundamental differences between gas and steam engines, the ignition, starting, etc. 2500 w. Horseless Age, April 12, 1899. No. 27017.

Vehicle Motors.

See Automobilmism.

Windmills.

Improvements and Theories in Wind Motors. (Neuerungen und Theorien über Windmotoren.) R. Friedlaender. With curves showing the relation between velocity and capacity and especial data from the performance of the pumping plant at Heiligenstadt. 4000 w. Mett d Ver f d Ford d Local u Strassen-balmwesens—March, 1899. No. 27273 D.

STEAM ENGINEERING.

Allen Valve.

The Allen Valve for Locomotives. C. H. Quereau. Presents the objections and advantages of this double-ported valve. 2200 w. Trans Am. Soc of Mech Eng—May, 1899. No. 27197 D.

Boiler Explosions.

Investigations of Boiler Explosions. Gus C. Henning. Discusses the fundamental causes of explosions, showing that careful testing and inspection will always be sufficient to demonstrate the cause of any boiler explosion. 2000 w. Trans Am Soc of Mech Eng—May, 1899. No. 27195 D.

Boilers.

Practical Experience on the Strength of Boilers. C. E. Stromeyer. Abstract of a paper read before the British Inst. of Naval Arch'ts. Analyses results obtained and considers general practice in land boilers as compared with Lloyds rules. 2500 w. Eng. Gaz—April, 1899. No. 26994 A.

Boiler Trials.

Report of the Committee on the Revision of the Society Code of 1885, Relative to a Standard Method of Conducting Steam Boiler Trials. A copy of the revised code, the changes being chiefly in the line of amendments which experience has shown to be desirable. Ill. 36500 w. Trans Am Soc of Mech Eng—May, 1899. No. 27185 D.

Calorimetry.

Calorimetric Experiments at the Magdeburg Boiler Testing Laboratory. (Kalorimetrische Ergebnisse aus dem Laboratorium des Magdeburger Vereines für Dampfkesselbetrieb.) L. C. Wolff. With tabulated results of tests of the calorific power of a large number of coals and an account of the trials; the Krökerbomb was used. 3000 w. Zeitschr d Ver Deutscher Ing—March 25, 1899. No. 27-205 D.

Coal Tests.

See Mining and Metallurgy. Coal.

Condensing.

Central Steam Condensing Plants. From *Stahl und Eisen*. Illustrates and

describes a plant and apparatus for the condensing of the exhaust steam from various engines. 3800 w. *Ir Age*—April 20, 1899. No. 27102.

Design.

High Speed Engine Design. Practical hints relating to the design of the ordinary double-acting engine of the vertical inverted cylinder type. Ill. 1300 w. *Mech Wld*—March 24, 1899. Serial. 1st part. No. 26851 A.

Efficiency.

Boiler and Furnace Efficiency. R. S. Hale. Considers the means of determining boiler efficiency and its dependence on the efficiency of combustion and air supply. Tabulated results of tests are given. 6500 w. *Trans Am Soc of Mech Eng*s—May, 1899. No. 27198 D.

Feed Waters.

The Scientific Treatment of Boiler Feed Waters. J. H. Parsons. On the trouble arising from imperfect samples sent for analysis, and the failures due to the steam-users, with report of some of the worst varieties sent for analysis during the past few months. 1400 w. *Eng & Min Jour*—April 15, 1899. No. 27050.

Governors.

Notes on Shaft Governors. W. B. M'Lean. Deals with practical points in the design of these appliances, noticed by the writer during work connected with high-speed engines which were thus governed. Ill. 2500 w. *Can Engr*—April, 1899. No. 26970.

High-Pressures.

Effects of High Pressure Steam on Engine Cylinders. F. W. Roller. Reports the successful method of dispensing with lubricants in engines of the vertical type. 1300 w. *Am Elect'n*—April, 1899. No. 26956.

Jacketing.

A Study of the Function of the Steam Jacket. (Etude du Role de l'Enveloppe de Vapeur.) M. Lefer. A critical analysis of the influence of the jacket on steam economy under various conditions, with indicator diagrams. 6000 w. *Bull de la Soc d'Encour*—March, 1899. No. 27-230 G.

Naval Boilers.

The Naval Boiler of the Future. Considers what ought to be the characteristics of the ruling type, and how far any one of several boilers is likely to comply with these conditions. 2500 w. *Engr*. Lond—April 14, 1899. Serial. 1st part. No. 27168 A.

Separator.

Test of a Steam Separator. F. L. Emory. Record of a test of a baffle-plate

pattern separator designed to serve as a live-steam separator, as an exhaust-steam separator or trap, and as an oil extractor. 1300 w. *Trans Am Soc of Mech Eng*s—May, 1899. No. 27192 D.

Specifications.

Engine Specifications. An editorial on the proper method of calling for tenders for an engine plant where special machinery is not wanted. 1600 w. *Eng Rec*—April 1, 1899. No. 26879.

Engine Specifications. Letters from R. H. Thurston and W. H. Bryan on the best method of writing specifications for engines without special features which are to be installed for private parties. 2500 w. *Eng Rec*—April 15, 1899. No. 27044.

Steam Economy.

The Dependence of Economy Upon Load in Steam Engines. (In Welcher Weise ändert sich mit der Belastung der Dampfverbrauch einer Dampfmaschine?) E. Meyer. A careful study of steam economy, comparing load curves and steam consumption, with a mathematical analysis of their relation. 2500 w. *Zeitschr d Ver Deutscher Ing*—April 8, 1899. No. 27208 D.

Steam Engines.

The Steam Engine. A. Selwyn Brown. Part first considers various rotary engines of recent invention. Ill. 1800 w. *Aust Min Stand*—March 9, 1899. Serial. 1st part. No. 27008 B.

Steam Pipes.

Steam Pipes. J. T. Milton. Full abstract of a paper read before the British Inst. of Naval Archts. Considers the materials used, their design, the conditions in actual use, etc. Ill. 5000 w. *Engs Gaz*—April, 1899. No. 26992 A.

Steam Piping. Review of a paper by J. T. Milton before the Inst. of Nav. Archts. with discussion. 2300 w. *Eng Rec*—April 15, 1899. No. 27045.

Superheating.

Recent Practice in Steam Superheating. Illustrates and describes a new apparatus for superheating steam, giving records of tests and editorial on progress made in Europe, and the interest aroused in the United States. 4200 w. *Eng News*—April 6, 1899. No. 26944.

Valves.

A New System of Valves for Steam Engines. Air Engines and Compressors. Fred W. Gordon. Illustrates and outlines a system of valves showing their adaptability to shaft governed or automatic vibrating engines. 3500 w. *Trans Am Soc of Mech Eng*s—May, 1899. No. 27189 D.

MISCELLANY.

Inclined Planes.

A Graphical Treatment of the Problem of the Rough Inclined Plane. G. A. Burls. Three cases are considered. 800 w. Engng—April 14, 1899. No. 27166 A.

Liquid Air.

Liquid Air and Its Phenomena. W. C. Peckham. Illustrates and describes experiments with liquid air and apparatus used in compressing. Methods of measuring low temperatures are described. 4200 w. Sci Am Sup—April 27, 1899. No. 27320.

Liquid Air and Low Temperatures. W. H. Swenarton. Reviews the methods of producing low temperatures, and the attempts made to liquefy gases, giving experiments made with liquid air. 2700 w. Yale Sci M—April, 1899. No. 27104 C.

Liquid Air as a New Source of Power—Another Engineering Fallacy. Henry

Morton. A criticism of an article in the March number of *McClure's Magazine*, showing the statements made to be impossible and misleading. 1800 w. Stevens Ind—April, 1899. No. 27122 D.

On the Liquefaction of Air by Dynamical Action. J. E. Denton. Experimental study. Ill. 2200 w. Stevens Ind—April, 1899. No. 27123 D.

The Possibilities of Liquid Air. Elihu Thomson. An exhaustive discussion by a leading authority, of the problems connected with the manufacture, cost, utilization, and mechanical value of liquid air, from the standpoint of the engineer. 4000 w. Engineering Magazine—May, 1899. No. 27281 B.

Paris Exposition.

American Exhibits at the Paris Exposition. A statement of the importance of a good display from the United States, and an explanation of the arrangement of exhibits and of the jury system. 1500 w. Eng Rec—April 15, 1899. No. 27034.

MINING AND METALLURGY

COAL AND COKE.

Coal-Cutters.

Two Types of Electrical Coal-Cutters. Thomas H. Barr. From a paper read before the Min. Inst. of Scotland. Describes the Hurd coal-cutting machine and the Clarke electric coal-cutting machine. 1600 w. Col Guard—April 14, 1899. No. 27160 A.

Coal Tests.

Comparative Tests of Bituminous Steam Coals. John W. Hill. A full account of experimental investigations carried on at Cincinnati, in 1897-98, with results. Ill. 14000 w. Pro Am Soc Civ Eng—April, 1899. No. 27304 E.

Colliery Accounts.

The Application of the Double-Account System to Collieries. George Johnson. Gives an illustration of colliery accounts drawn up on the single and double account systems, with comments. 1200 w. Col Guard—April 7, 1899. No. 27089 A.

Culm.

The Accumulations of Culm in the Coal Regions and Their Utilization for Power Purposes. Harry N. Gardner. Showing that progress in furnaces and grates has made it possible to burn much of this culm with profit. Ill. 1400 w. Am. Elect'n—April, 1899. No. 26955.

The Yield of the Reynolds Anthracite Culm Bank. A. De W. Smith. Illustrates

the washery at Plymouth, Pa., giving results of the production. 600 w. Eng & Min Jour—April 15, 1899. No. 27048.

Cumberland Region.

Georges Creek—Cumberland Coal Region. Beverley S. Randolph. Describes the geological peculiarities, the qualities of coal, and methods of working. Ill. 2000 w. Mines & Min—April, 1899. No. 26916 C.

Occluded Gases.

The Gases Occluded in Hard Coal. (Ueber die in Steinkohlen Eingeschlossenen Gase.) Dr. Broockman. A review of the various investigations which have been made, together with analyses, and a discussion of the relation of occluded gases to coal-dust explosions. 2500 w. Glückauf—April 1, 1899. No. 27260 B.

Russia.

Notes of a Trip in the North-western Portion of the Basin of the Donez. (Mitteilungen von einem Ausfluge nach dem Nordwestlichen Teile des Donez-Beckens.) G. Franke. An excellent account of this important coal field of Southern Russia, with geological map. 5000 w. 1 plate. Glückauf—March 18, 1899. No. 27259 B.

COPPER.

Auriferous Copper.

The Sampling of Argentiferous and

Auriferous Copper. Albert R. Ledoux. Read at meeting of the Can. Min. Inst. Describes the three methods now in use; boring, taking dip samples and by sawing. Ill. 3000 w. Can Min Rev—March 31, 1899. No. 26899 B.

California.

Copper Resources of California. Herbert Lang. Part first gives an account of the Iron Mountain mine of Shasta County. 2000 w. Eng & Min Jour—April 15, 1899. Serial. 1st part. No. 27049.

Paradox Valley.

The Great Paradox Region. A. B. Frenzel. A description of this valley, the copper mines, etc. 2500 w. Ores & Metals—March, 1899. No. 26878.

Production.

Copper Production and Prices. Discusses the production, consumption, available supply and conditions that have affected prices. 2200 w. Engng—March 24, 1899. No. 26867 A.

GOLD AND SILVER.

Chlorination Plant.

The Utica Mine Chlorination Plant. Thomas N. Smith. Illustrates and describes this California plant, giving itemized statement of cost. 1000 w. Eng & Min Jour—April 22, 1899. No. 27116.

Coinage.

"The Trial of the Pyx," or the Proceedings of the Assay Commission for Testing the Weight and Fineness of the U. S. Coinage. A history of the ancient custom and a description of the methods of sampling and assaying which are now practiced in the United States. Ill. 3300 w. Mines & Min—April, 1899. No. 26913 C.

Cyanide.

The Netto Process for the Treatment of Gold and Silver Ores. (Le Procédé Max Netto pour le Traitement des Minerais d'Or et d'Argent.) L. Legrand. A description of a modified cyanide process as used at the mines at Horcajo, Spain. 3000 w. Rev Univ des Mines—Feb., 1899. No. 27251 G.

Drift Mine.

The Magalia, Cal., Drift Mine. A. D. Gassaway. An account of the discovery, the channel, methods of working gravel, timbering, etc., with illustrations. 3200 w. Min & Sci Pr—April 8, 1899. Serial. 1st part. No. 27032.

Milling.

The German Gold Milling System. F. Hille. Advantages claimed for it over the methods generally employed in the United States. Ill. 1400 w. Mod Mach

—April, 1899. Serial. 1st part. No. 26896.

Nova Scotia.

On the Gold Measures of Nova Scotia and Deep Mining. E. R. Faribault. Descriptive account of the geological changes and their results, giving the present features. 4000 w. Can Min Rev—March 31, 1899. No. 26900 B.

Placers.

Dry Gold Placers of the Arid Regions. George H. Stone. The difference in the methods by which they and the wet placers were deposited and the reasons for the failure of so many dry placer machines. 3700 w. Mines & Min—April, 1899. No. 26914 C.

Precipitation.

The Chemical Precipitation of Gold. P. de Wilde. A reply to the discussion on the writer's process of gold extraction, and also a paper by William Bettel, replying to the paper given. 6300 w. Jour of Chem & Met Soc of S Africa—Feb., 1899. No. 27147 E.

Production.

Gold and Silver Production. Reviews the production of the last few years in various parts of the world. 2000 w. Engr, Lond—April 14, 1899. No. 27169 A.

Slimes.

The Lixiviation of Slimes. Alfred James. Compares the results obtained at Kalgoorlie with those of the Witwatersrand. 1100 w. Eng & Min Jour—April 1, 1899. No. 26907.

Smelters.

Smelter and Other Trusts. W. C. Wynkoop. Remarks on the former effort to establish a trust, on the effect on labor and industry, and on trusts in general. 1500 w. Ores & Metals—March, 1899. No. 26877.

Sultana Lode.

Description of the Sultana Quartz Lode and the Sinking of the Burley Shaft in Bald Indian Bay, Lake of the Woods. J. Burley Smith. Ill. 2300 w. Can Min Rev—March 31, 1899. No. 26898 B.

Veins.

Some Characteristic Features of Veins in Granite in California. W. H. S. Describes a peculiar gold-bearing vein formation. 2800 w. Min & Sci Pr—April 22, 1899. No. 27329.

West Kootenay.

West Kootenay Ore Bodies. R. W. Brock. Read at meeting of the Canadian Min. Inst. Briefly reviews facts relating to the geology so far as it is connected with the ore deposits, and the ore de-

posits themselves. 5500 w. Can Min Rev—March 31, 1899. No. 26897 B.

Wyoming.

The Mineral Belt of the Sierra Madre Range of Mountains in Southern Wyoming. E. P. Snow. The location, discovery, development and account of the principal mines. Ill. 2400 w. Min Rept—April 6, 1899. No. 27092.

IRON AND STEEL.

Chemistry.

See Mechanical Engineering, Foundries.

Concentration.

The Magnetic Concentration of Iron Ores. (Magnetische Aureicherung von Eisenerzen.) Dr. Leo. A description of the Gröndal-Dellwik process of magnetisation and magnetic concentration as operated at Pitkäranta in Finland. 1500 w. Stahl und Eisen—March 15, 1899. No. 27255 D.

Hot Blast.

The Equalization of the Temperature of Heated Gases. (Verfahren Zum Ausgleichen der Temperatur Heisser Gase.) An illustrated description of the Gjers and Harrison arrangement of hot-blast stoves by which the fluctuations in temperature are avoided. 1200 w. Stahl und Eisen—March 15, 1899. No. 27256 D.

Lake Superior.

Methods of Mining Iron Ore in the Lake Superior Region. Nelson P. Hulst. Descriptions of the methods used, with illustrations. 10500 w. Pro of Eng's Soc of W. Penn—Feb., 1899. No. 27100 D.

Magnetic Deposits.

The Use of Magnetic Instruments for Discovering Magnetic Ore Deposits. G. Nordenstrom. On the use of these instruments in Sweden, showing the advantages and usefulness to be beyond question. Ill. 2000 w. Ir Age—April 13, 1899. No. 27007.

Oxygen.

The Combined Oxygen in Steel. (Ueber den Sauerstoffgehalt des Stahls.) A. Ledebur. A discussion of the influence of combined oxygen, and of the best methods of determining the amount present. 3000 w. Stahl und Eisen—March 15, 1899. No. 27254 D.

Steel.

Influence of Arsenic on the Mechanical Properties of Steel. M. J. Marchal. Extract from the Bulletin de la Société d'Encouragement. Reports a series of experimental tests, concluding that steel otherwise pure will not suffer by the presence of such amounts of arsenic as are occasionally found, though defects

due to other impurities may be increased by its presence. 800 w. Ir Age—April 13, 1899. No. 27006

MINING.

Air-Shafts.

Upcast Air Shaft Fitted for Winding with 12-Decked Cages. M. Ghysen. From a communication to the Liège Engs' Assn. Describes the conditions which led to the use of 12-decked cages, and their use and movement. Ill. 2609 w. Col Guard—April 14, 1899. No. 27159 A.

Cavilling.

The Cavilling System. M. I. M. E. An explanation of this system and a discussion of whether it pays. 4000 w. Col Guard—March 30, 1899. No. 27003 A.

Electric Power.

Electricity in Mining. William Maurice. Abstract of a paper read before the Chesterfield and Midland Counties Inst. Part first deals with electric blasting, mainly in its connection with coal mining. 2200 w. Aust Min Stand—March 9, 1899. Serial. 1st part. No. 27009 B.

Explosives.

The Theory of Safety Explosives. From a communication by Bergassessor Heise to *Gluckauf*. Discusses the conclusions reached by the Prussian Firedamp Commission, and the French investigators, and gives the opinions of the writer. 3300 w. Col Guard—April 14, 1899. No. 27161 A.

Lamp.

Improved Form of Sussman Lamp for Belgian Collieries. From a communication of M. A. Abrassart, to the Société des Ingenieurs Sortis de l'Ecole des Mines du Hainaut. Illustrates and describes the improvements, and states the advantages and disadvantages. 2400 w. Col Guard—March 30, 1899. No. 27004 A.

Mine Timber.

Mine Timber, its Choice and Preservation. Arthur Lakes. Reviews the various timbers used, mentioning some curious kinds the use of which is necessitated in high and arid regions. Also considers methods of preservation. Ill. 1700 w. Mines & Min—April, 1899. No. 26917 C.

Mining Laws.

Chamber of Mines, N. S. W. Suggestions for the amendment of mining laws submitted to the Minister for Mines. 2209 w. Aust Min Stand—Feb. 25, 1899. No. 26841 B.

Lodes vs. Placers. F. T. Freeland. Discusses an opinion rendered by Justice Goddard in the Supreme Court of Colorado, and also other decisions. 900 w.

Eng & Min Jour—April 1, 1899. No. 26908.

Pumps.

Care of Mining Pumps. George D. Rice. Considers the various things that cause trouble and means of remedying them. 1800 w. Min Rept—April 13, 1899. No. 27094.

Pumping Plant at Houghhead Colliery. Illustrates and describes a plant recently erected near Glasgow, and the trial. 1200 w. Engr, Lond—April 7, 1899. No. 27-086 A.

See Mechanical Engineering, Hydraulics.

Rescue Appliances.

Rescue Appliances in Mines. G. A. Meyer. From a lecture delivered before the Verein der Technischen Grubenbeamten at Herne. Illustrates and describes the system in use at Shamrock Colliery. 3400 w. Ir & Coal Trds Rev—April 14, 1899. No. 27174 A.

Shafts.

Means for Preventing Accident in Mine Shafts. Victor Watteyne. From a communication to the *Annales des Mines de Belgique*. Deals with accidents in connection with winding, and with air and pumping shafts, also at landings. 5000 w. Col Guard—March 24, 1899. Serial. 1st part. No. 26876 A.

Shaft-Sinking.

The Sinking of Shafts No. 5, 6 and 7, at the Bascoup Colliery, Belgium. (Enfouissements des Puits No. 5, 6 et 7, du Charbonnage de Bascoup.) E. Briart. Especially devoted to the methods used in sinking through watery strata of sand, and layers of clay, by the use of metallic tubing. 3500 w. 1 plate. Rev Univ des Mines—March, 1899. No. 27253 G.

Ventilators.

Compression Ventilators in German Coal Mines. From *Zeitschrift für Berg-Hütten-und Salien Wessen*. Translation of paper by Bergassessor Steinhoff. Illustrated description of the system, with statement of its advantages. 1800 w. Eng & Min Jour—April 8, 1898. No. 26985.

MISCELLANY.

Aluminum.

The Properties and Applications of Aluminum. (Sur les Propriétés et les Applications de l'Aluminum.) A. Ditte. Particularly devoted to the durability of the utensils used by the French soldiers in Madagascar, and indicating the metal to be less adapted for such purposes than has been supposed. 3000 w. Comptes Rendus—March 27, 1899. No. 27245 D.

Charleroi.

A Tour in the Charleroi District, Belgium. (Excursions dans le Bassin de

Charleroi.) M. J. Smeysters. An account of the visit of a party of engineers to the various mining and metallurgical establishments in the district about Charleroi, Belgium, with much information of interest. 10,000 w. 3 plates. Rev Univ des Mines—Jan, 1899. No. 27250 G.

Clay.

Clay Mining. E. Lovejoy. A description of the methods employed in mining clay by the Columbus Brick and Terra Cotta Co., at Union Furnace, O. 1600 w. Mines & Min—April, 1899. No. 26-912 C.

Cornwall.

Crushing and Concentration at Dolcoath Mine, Cornwall. R. Arthur Thomas. Notes the changes which gradually led to the introduction of automatic machinery, and the economy secured. 2000 w. Col Guard—April 14, 1899. No. 27-162 A.

Fuel Gas.

See Gas Engineering.

Manganese.

Some Sources of Manganese Ore Supply. An account of the deposits in the Caucasus, Brazil, and Cuba, with the characteristics, methods of treating, cost of production, transportation, etc. 4800 w. Ir & Coal Trds Rev—April 7, 1899. No. 27088 A.

Mineral Resources.

Mineral Resources of the Antilles, Hawaii, and the Philippines. David T. Day. A review by the chief of the Statistical Division of the U. S. Geological Survey, of the mineral resources of these islands, giving a resumé of the latest official information. 4000 w. Engineering Magazine—May, 1899. No. 27285 B.

Onyx.

The Kentucky Onyx Fields. S. S. Sorby. A description of the formation of onyx with illustrated account of the deposits named, and general remarks. 1700 w. Am Mfr & Ir Wld—March 31, 1899. No. 26906.

Ores.

The Genesis of the Deposition of the Ores of Metals in the Earthcrust. Carl Wulsten. Gives the writer's views, based on 40 years of observation, study and work. 1800 w. Min Rept—April 6, 1899. No. 27093.

Quicksilver.

Quicksilver Reduction at New Almaden Mines, California. Arthur Lakes. A description of some of the furnaces formerly used and those at present employed for reducing both fine and coarse

ores. Ill. 4000 w. Mines & Min—April, 1899. No. 26915 C.

Rock Salt.

Rock Salt Mining at Heilbronn. (Mittheilungen über den Steinsalz-Bergbau in

Heilbronn.) Alexander Iwan. A general description of the geological conditions, and of the mechanical methods employed. Two articles. 5000 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—March 18, 25, 1899. No. 27258 each B.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Fatal Accidents to Trainmen in 1893 and 1897. Editorial showing that the annual report of the Interstate Commerce Commission may show a possible error in the statistics. 1400 w. R R Gaz—April 14, 1899. No. 27029.

Train Accidents in the United States in February. Detailed list and classified summary. 4500 w. R R Gaz—April 14, 1899. No. 27030.

Speed.

Speed of Express Trains in France. A free translation of an article by Mr. Varennes which appeared about three years ago, covering the period from 1854 to 1895 inclusive. 2700 w. R. R. Gaz—April 7, 1899. No. 26948.

Trains Parting.

The Cause of Trains Parting and the Best Methods of Preventing Same. Extracts from a paper prepared by a committee of members of the Assn. of R. R. Air Brake Men, with comments. 2000 w. Ry & Engng Rev—April 22, 1899. No. 27178.

Train Rules.

Revised English Train Rules. Considers some of the rules which are of special interest to this country. 2100 w. R R Gaz—April 14, 1899. No. 27027.

The Standard Code of Train Rules of the American Railway Association for Single Track. A copy of the rules adopted at Detroit, April 12, 1899. 5200 w. R R Gaz—April 21, 1899. No. 27115.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

A New Device for Preventing the Sliding of Car Wheels by Air Brakes. Illustrates and describes a device, designed for use in connection with the ordinary air brake, which is being tried on the Pacific coast. 800 w. Eng News—April 20, 1899. No 27111.

Car Repairs.

Additional Compensation for Car Repairs Done West of the 105th Meridian.

J. H. Goodyear. Discussing the schedule of prices and the allowing of a differential charge to give relief to roads making repairs at a loss. 2700 w. R R Car Journal, April, 1899. No. 26989.

Cars.

Light and Heavy Cars. O. H. Reynolds. Discussion showing the effect of the heavy car on the revenue of railways. Ill. 3300 w. Am Eng & R R Jour—April, 1899. No. 26902 C.

Car Wheels.

See Mechanical Engineering, Machine Works.

Corridor Car.

Corridor Cars of the Eastern Railway of France. (Les Wagons à Intercirculation de la Compagnie de l'Est). D. Bellet. Illustrated description of these new railway carriages; a corridor along one side enables circulation to be made through the train without passing through the compartments. 2000 w. 1 plate. Revue Technique—April 10, 1899. No. 27218 D.

Couplers.

The Automatic Couplers Bill. A statement of the case against the coupler section of the Regulation of Railways Bill, in England. Ill. 3500 w. Transport—March 17, 1899. No. 26848 A.

Dynamometer.

The Teodorovitch Dynamometric Apparatus. (Appareil Dynamometrique de M. Teodorovitch.) H. Chevalier. An illustrated description of an improved dynamometer for the measurement of train resistance, as used on the Kharkow-Nicolaiew Railway, Russia. 2500 w. Soc Ing Civ de France—Jan. 1899. No. 27234 G.

Fireboxes.

Tests on Wide and Narrow Fireboxes. H. H. Vaughn. Illustrated account of the tests made by the Philadelphia & Reading Railway. 1800 w. Am Eng & R R Jour—April, 1899. No. 26901 C.

Gondola Car

80,000-Pounds Capacity Gondola Car for the Lake Shore and Michigan Southern Railway. Engravings showing the

principal features, with brief description. 800 w. R R Gaz—April 28, 1899. No. 27333.

Lavatory Carriage.

Lavatory Carriage, London and South Western Railway Co. Illustrates and describes a car recently built for service on this line, which combines peculiarities of the American and English practice. 2300 w. R R Car Jour—April, 1899. No. 26990.

Locomotives.

A Link in Early Locomotive History. The share taken in the development by the firm of Messrs. Mather, Dixon & Co., of Liverpool. 1800 w. Engr, Lond—April 14, 1899. No. 27170 A.

A Once Famous Locomotive. Charles Rous-Marten. An account of the runs of engine 123, of the Caledonian Railway, with its history and recent trial. 3200 w. Engr, Lond—March 31, 1899. No. 26972 A.

A. Rogers' 10-Wheeler for the Great Northern. Engraving and descriptive specifications. 2500 w. R R Gaz—April 28, 1899. No. 27337.

A Schenectady 8-Wheeler for the Vandalia Line. Illustration with dimensions. 600 w. R R Gaz—April 28, 1899. No. 27336.

Compound Locomotives on the Northern Pacific Ry. Edwin M. Herr. Abstract of a paper read before the Western R'y Club. An interesting account of the different systems of compounding employed, and the types and other particulars. 3800 w. Eng News—April 27, 1899. No. 27339.

Compound Locomotives on the N. P. R'y. Data from the paper of E. M. Herr, presented at the March meeting of the Western Ry. Club. 2000 w. Ry & Engng Rev—April 22, 1899. No. 27175.

Heavy Consolidation Locomotive for the Cleveland, Cincinnati, Chicago & St. Louis Railway. Illustrated description with principal dimensions of the largest locomotive so far built for this road. 700 w. R R Gaz—April 28, 1899. No. 27335.

Running a Vauclain Compound. C. G. Herman. Describes what the writer considers the best method of handling this type of locomotive. 1600 w. Loc Engng—April, 1899. No. 26854 C.

Six-Coupled Compound Express Engine. Illustrates and describes a new type lately put into service on the Austrian State Railways. 700 w. Engr, Lond—March 31, 1899. No. 26976 A.

The Development of the Four-Cylinder Compound. Statement made by R. H. Soule, at meeting of the Western Railway Club, of the changes which have been made in the four-cylinder compound. 700 w. R R Gaz—April 28, 1899. No. 27334.

The Movements in Locomotives and

their Influence upon the Rails. (Die Eigenbewegungen der Lokomotiven und Ihre Einwirkung auf die Gleise.) H. von Borries. A paper before the German Railway Society showing the influence of the internal motions of a locomotive upon the rails; with discussion. 3500 w. Glaser's Annalen—April 1, 1899. No. 27248 D.

Resistance.

Resistance of Empty and Loaded Coal Cars. Gives the results thus far obtained in investigations. 1000 w. R R Gaz—April 14, 1899. No. 27028.

Side Rods.

Cast Steel Side Rods. Illustrates and describes the practice of the Philadelphia & Reading, as applied to consolidation engines. 500 w. Am Engr & R R Jour—April, 1899. No. 26903 C.

Testing Locomotive.

The New Testing Locomotive at Columbia University. Herbert T. Wade. Illustrated description of the full size passenger locomotive, the gift of the Baldwin Locomotive Works, of Philadelphia. 1300 w. Sci Am—April 15, 1899. No. 27015.

Valve Gear.

A Special Valve Gear. (Une Distribution Speciale.) M. F. Panoux. A description with valve diagrams, of a locomotive cut-off valve gear used on the Northern Railway of Spain. The cut-off valve, riding on the main slide valve, is operated from a point on the link. 2500 w. 1 plate. Rev Gen des Chemins de Fer—April, 1899. No. 27233 F.

Vestibules.

See Street and Electric Tramways.

NEW PROJECTS.

Africa.

The Cape to Cairo Railroad. H. G. Prout. Extracts from an article in Munsey's Magazine for April, giving information concerning this project, its cost, and other means of attaining the same ends at less expense. 1200 w. R R Gaz—April 14, 1899. No. 27025.

Colorado.

Notes on Colorado Railways. Gives interesting profiles, sketch map and illustrations, with particulars of various lines. 3500 w. Eng News—April 6, 1899. No. 26943.

Far East.

Railway Connection Between Burma and China. Editorial on the paper of Dr. John Nisbet, recently read before the Society of Arts. 2800 w. Engng—April 7, 1899. No. 27078 A.

Japan.

Railways in Japan. An account of the railway development, the supervision by

the Government, the individual lines and general results. Map. 2500 w. Engng—April 14, 1899. No. 27163 A.

Mountain Railway.

The Electrically-Driven Mountain Rope Railway at Mont-Dore. Translation of an article in *Elektrotechnische Zeitschrift*. Describes a railway said to be the only example of its kind in Europe. 1500 w. Elec Eng, Lond—March 31, 1899. No. 26996 A.

The Nilgiri Mountain Railway. An illustrated account of this Indian railway and its equipment. 1100 w. Engr, Lond—March 31, 1899. No. 26974 A.

Railway Location.

Rules for Railway Location and Construction; Northern Pacific Ry. Extracts from the rules and instructions for the engineering and construction departments, with editorial comment. 11400 w. Eng News—April 20, 1899. No. 27113.

Russia.

The White Sea Railway. A brief account of this project and the advantages it will bring to Russia and Finland. 900 w. Engr, Lond—April 7, 1899. No. 27084 A.

Trans-Siberian.

The Trans-Siberian Railway. Details concerning the state of the work, taken from the official report. 1600 w. Engr, Lond—April 7, 1899. No. 27083 A.

Yukon Railway.

Opening the White Pass and Yukon Railway. W. M. Sheffield. Information concerning this great engineering feat, and the portion of the road already constructed. Ill. 1200 w. Sci Am—April 15, 1899. No. 27012.

PERMANENT WAY AND FIXTURES.

Boston Station.

I. The Planning and Building of the Southern Station, Boston. George B. Francis. II. The Mechanical Equipment of the Southern Station. Henry J. Conant. An illustrated account of this large project and its many details is given in the first paper, while the second gives an illustrated description of the mechanical equipment, exclusive of track and structural work, which cost nearly three-quarters of a million dollars. 8400 w. Tech Quar—March, 1899. No. 27021 E.

Coaling Station.

The Jersey City Coaling Station of the Erie Railroad. Illustrated description of a plant that has proved efficient and economical. 1600 w. R R Gaz—April 14, 1899. No. 27026.

Curves.

The Determination of Elevation and Spread of Rails on Curves. (Zur Bestimmung der Ueberhöhungen und Erwerterungen in Eisenbahn-curven). Emil Masik. A very full discussion of the questions of the elevation of the outer rail and the proper spread for various curves and speeds. Two papers, 8000 w. Zeitschr d Oesterr Ing v Arch Ver—March 31, April 7, 1899. No. 27210 each B.

Grade Crossings.

Proposed Abolition of Grade Crossings at Syracuse. An abstract of the report of Henry B. Seaman to the city government giving plans for a comprehensive treatment of the problem. 1600 w. R R Gaz—April 21, 1899. No. 27114.

Narrow Gauge.

Narrow Gauge Railways. F. J. E. Spring. Describes the Darjeeling-Himalayan railway, the Howrah-Amta and Howrah Sheakhalla tramways, the Barsi light railway and the Tezpur tramway. 3500 w. Ind & East Engr—Feb., 1899. No. 26850 D.

Railroad Bridge.

See Civil Engineering, Bridges.

Railroad Ties.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Walter W. Curtis. A review of knowledge on this subject and a report of the critic's investigations. 2000 w. Pro Am Soc Civ Engs—April, 1899. No. 27305 E.

Road Bed.

Permanent Way Construction in Tunnels. (Le Mode de Pose de la Voie des Chemins de Fer dan les Souterrains). J. Michel. An argument against the use of ballast for underground roads or in tunnels, and a recommendation of stringers laid in concrete. 3500 w. Rev Gen des Chemins de Fer.—April, 1899. No. 27232 F.

Signals.

A Code of Positive Signals. Editorial discussion of the difficulties, and of the changes recently made by the officials of the N. Y., N. H., & H. R. R. 1800 w. Loc Engng—April, 1899. No. 26855 C.

Block Signaling on the Atchison, Topeka & Santa Fe Railway. Describes the system of this road which has about one-fifth of its line operated on this plan. 1300 w. Eng News—March 30, 1899. No. 26863.

Electric Signal Systems for Railways. (Ueber Elektrische Signalisirung der Gleiswege.) A paper by Director Othe-graven before the German Railway Society, discussing especially signalling in

terminal stations and yards. 2500 w. Glaser's Annalen—April 1, 1899. No. 27-249 D.

Yellow as a Color for Distant Signals. N. Y., N. H. & H. R. R. Discusses the need of a third color and the study that has been given the problem, with the decision of the road named. 1600 w. Am Engr & R R Jour—April, 1899. No. 26904 C.

Station Grounds.

Landscape Gardening on the Boston & Albany. Ellen F. Blodgett. An ac-

count of the artistic work which has so greatly added to the beauty of the route. 800 w. R R Gaz—April 7, 1899. No. 26947.

TRAFFIC.

Bicycles.

Bicycle Traffic on the Long Island Railroad. Illustrated detailed description of methods used by this road, which carried over 176,000 wheels in six months. 1300 w. R R Gaz—April 7, 1899. No. 26949.

STREET AND ELECTRIC TRAMWAYS

Algiers.

Electric Railway in Algiers. Illustrated description of a line operated by a French Company, connecting Algiers with neighboring towns. 1800 w. St Ry Jour—April, 1899. No. 26921 D.

Boston Elevated.

The Central Power Station of the Boston Elevated Railway. H. W. Weller. Brief historical sketch and detailed description of the arrangement and equipment of this station. 4500 w. Ry Wld—April 13, 1899. No. 27330 A.

Carriage Works.

The Electric Railway and Tramway Carriage Works. Illustrated detailed description of the new factory at Preston, England, and the course of car construction, power distribution, etc. 2300 w. Ry Wld—April 13, 1899. No. 27-332 A.

Preston Works.

See Mechanical Engineering, Machine Works.

Rapid Transit.

Expert Opinion of the New Rapid Transit Proposition in New York. Letter from Stuyvesant Fish, president of the Illinois Central, containing valuable suggestions based on experience. 2800 w. St Ry Jour—April, 1899. No. 26-920 D.

Rapid Transit in Dense Centers of Population. John Lundie. On the problem in New York, and the importance of speed on elevated roads. 2400 w. St Ry Jour—April, 1899. No. 26923 D.

The Cost of Speed in Rapid Transit Service. J. R. Cravath. An investigation of the relative cost of various schedule speeds under a given set of conditions. 4000 w. Elec Wld & Elec Engr—April 1, 1899. Serial. 1st part. No. 26889.

The New York City Rapid Transit Proposition of the Metropolitan Street Railway Company. A copy of the proposal of the Metropolitan St. Ry. Co., with explanation of the plan, and editorial. 5500 w. St Ry Jour—April, 1899. No. 26924 D.

Repairing.

Steel in Car Repairing. W. H. Glenn. Suggestions relating to repairs and where steel can be substituted advantageously for wood. Ill. 1800 w. St Ry Rev—April 15, 1899. No. 27057 C.

Repair Shops.

See Mechanical Engineering, Machine Works.

Rolling Stock.

Maintenance and Repairs of Rolling Stock. J. W. Greer. Part first is largely introductory and considers the labor account. 1800 w. St Ry Rev—April 15, 1899. Serial. 1st part. No. 27058 C.

Third-Rail System.

A Sectional Third-Rail Electric Street Railway System. Describes the 2000-ft. experimental section of track at Manhattan Beach, of the Murphy Safety Third-Rail System, stating the advantages claimed and the defects. Ill. 1600 w. Eng. News—April 27, 1899. No. 27343.

Three-Phase.

Chicago and Milwaukee Three-Phase Electric Railway. S. S. Sherman. Illustrated detailed description of the new Chicago and Milwaukee line. 4000 w. Elec Wld & Elec Engr—April 8, 1899. No. 26967.

Tramways.

Electric Traction and Its Application to Suburban and Metropolitan Railways.

Philip Dawson. A paper aiming to show the adaptability of this motive power to the rapid transportation of large crowds from and to their business in large cities. 8700 w. Jour Soc of Arts—March 24, 1899. No. 26865 A.

Newcastle Tramway. Full text of the report of W. George Laws on the question of the introduction of electric tramways into that city, and the most desirable system to adopt. 5200 w. Elect'n, Lond—April 14, 1899. No. 27150 A.

The Development of Electric Tramways in the United Kingdom. Reviews the changes and progress, and gives Mr. Parshall's reasons for opposing the combining of lighting and tramway business. 2400 w. St Ry Rev—April 15, 1899. No. 27059 C.

The Relations of Municipalities and Their Street Railways. John W. Boyle. Considers the benefits, the liability for paving from the company's point of view, etc. 3500 w. St Ry Rev—April 15, 1899. No. 27060 C.

Transportation Problems.

Some of the Larger Transportation Problems in Cities. Edward E. Higgins. An explanation of the scheme of modern street railroading and the problems to be solved. 5000 w. Jour Fr Inst—April, 1899. Serial. 1st part. No. 26954 D.

Traveling Platform.

History of the Attempts at Continuous

Locomotion. (Historique des Tentatives de la Locomotion par Entraînement Continu.) M. Armengaud. An historical review of the various schemes which have been advanced for a traveling platform, down to the present device adopted for the exposition of 1900. 4500 w. 1 plate. Soc Ing Civ de France—Feb., 1899. No. 27240 G.

Underground.

New Life for the New York Underground Railway. A review of the terms under which the Metropolitan Street Railway Co., of New York, offered to build an underground railway in the city. 1300 w. Eng Rec—April 1, 1899. No. 26883.

Vestibules.

Arguments Against the Vestibuling of Cars. A letter addressed by John W. McNamara to the committee of railroads of the State Assembly of New York, arguing against the passage of bills in relation to the enclosing the platforms of cars of street railways. 1600 w. St Ry Jour—April, 1899. No. 26925 D.

Working Expenses.

Working Expenses of Electric and Cable Railways. Tables giving the working expenses, receipts, etc., of three railways in Great Britain. 1300 w. R. Wld—April 13, 1899. No. 27331 A.

NEW CATALOGUES AND TRADE PUBLICATIONS

*These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.*

The Brown Hoisting and Conveying Machine Co., Cleveland, O., U. S. A.=A very handsome and elaborately illustrated album of cranes and other hoisting machinery, including locomotive, cantilever and gantry cranes, electric traveling cranes, overhead tramrail and other devices for handling materials.

The National Meter Co., New York.=Catalogue of the Nash gas and gasoline engine, showing numerous applications for general driving as well as for direct-connected electric generators, and for pumping plants. Tables of sizes and capacities are given, and a number of testimonials are appended.

Library Bureau, Boston, Mass., U. S. A.=Classified illustrated catalogue of library supplies, including book stacks, furniture, card indexes, and every variety of material for the equipment of libraries, or for other systematical classification.

Brown & Sharpe Manufacturing Company, Providence, R. I., U. S. A.=Catalogue of Machine tools, gear cutters, standard rules and gauges and small tools. Many valuable tables for use in connection with gear cutting are given, and a number of machines and tools have been added since the issue of 1898.

Bates Machine Company, Joliet, Ill., U. S. A.=Catalogues (a) of the Bates Corliss engines of various designs and sizes; (b) of the Cookson feed-water heaters and receivers; (c) of a great variety of wire and wire-nail machinery; and (d) of a partial list of users of the Bates Corliss engines.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.=Record of Recent Construction, No. 12, being an illustrated pamphlet of locomotives built for use in various parts of the United States, as well as for Brazil, Hawaii, Cuba, Canada and Australia.

Michigan Pipe Company, Bay City, Mich., U. S. A.=Catalogue of creosoted wood tubing treated by the Bethell process, for casings for steam and gas pipes, and for conduits for electrical conductors.

Rochester Machine Tool Works, Rochester, N. Y., U. S. A.=Catalogue of the Acme automatic engines and boilers, for small powers, using oil fuel, or, if preferred, coal or wood. Details of the engines, boilers and atomizers are given, and numerous examples of successful application.

Fitchburg Steam Engine Co., Fitchburg, Mass., U. S. A.=Handsomely illustrated cata-

logue of the Fitchburg automatic steam engines, both high and low speed, simple and compound, also steam boilers and steam appliances. Details of the cutoff gear are given and an instructive comparison of indicator diagrams.

Hess, Snyder & Co., Massillon, Ohio, U. S. A.=Catalogue of friction clutch pulleys and friction clutch couplings, also plain and split cast iron pulleys, hangers, shafting, boxes, couplings and general machinery of transmission.

Potter & Johnston Co., Pawtucket, R. I., U. S. A.=Pamphlet catalogue of shaping machines, giving illustrations, description and detailed specifications of the 15- and 24-inch machines of modern design built by this firm.

The Mechanical Rubber Co., Chicago, Ill., U. S. A.=Catalogue and price list of rubber belting, hose, packing and a variety of miscellaneous mechanical rubber goods. A special telegraphic code is appended.

Greene, Tweed & Co., New York.=Well printed and illustrated catalogue of the Rochester automatic force feed lubricators, showing applications to various types of steam engines; also numerous testimonials from users.

Meriden Machine Tool Co., Meriden, Conn., U. S. A.=A Story Without Words, being a humorous exposition of the wide range of capacity of the Meriden forming lathe. A number of convenient accessories to the forming lathe are shown.

Ingersoll-Sergeant Drill Company, New York.=Catalogues (a) and index of Ingersoll-Sergeant Rock Drills, consisting of a brief illustrated list of the standard styles of the Ingersoll-Sergeant drills and being supplementary to the complete catalogue, No. 41; and (b) No. 25,000, being a handsome pamphlet commemorative of the completion of the twenty-five thousandth rock drill made by the company.

The John H. McGowan Co., Cincinnati, Ohio, U. S. A.=Booklet No. 25, listing and describing the designs of pumping machinery for which there is current demand, and intended as a guide to further detailed inquiries.

J. B. Colt & Co., New York.=Catalogues (a) of the Criterion Acetylene gas generator; (b) supplementary pamphlets Nos. 57, 60, 111, 120A and 121, describing various forms of the

generator for fixed and portable use, as well as for searchlights and contractors' lighting, together with the record of the underwriters' approval; (c) a pamphlet giving a general description of the properties of acetylene, the method by which it is generated and the numerous applications of which it is capable.

F. Cortez Wilson & Co., Chicago, Ill., U. S. A.=Pamphlets upon acetylene (a) describing the Acetogen, an apparatus for generating acetylene; (b) the acetylene dealers' handbook, containing general information regarding installations of plant, burners, etc.; and (c) a summary of opinions of eminent authorities of Europe and America upon the properties of acetylene, precautions to avoid danger, sound principles of generation, etc.

The Garton-Daniels Electric Company, Keokuk, Iowa, U. S. A.=Catalogue No. 22, describing the improved Garton lightning arresters, with illustrations showing their application in a great variety of cases for electric light, power and railway circuits of any voltage, direct or alternating current.

Anchor Electric Co., Boston, Mass., U. S. A.=Catalogue No. 8 of Anchor switches, push buttons, conduit boxes, sockets, cut-outs and other electrical supplies. A special telegraph code is appended.

D. R. Sperry & Co., Batavia, Ill., U. S. A.=Thirtieth annual price list of sugar kettles, cauldrons, farm boilers, ovens and supplies. Cauldrons as large as 500 gallons' capacity are listed, and various forms and settings are illustrated.

J. Stevens Arms & Tool Co., Chicopee Falls, Mass., U. S. A.=Pamphlet catalogue of calipers, dividers, surface gauges, nippers, protractors and other small tools for machinists' use.

Byram & Company, Detroit, Mich., U. S. A.=Pamphlet catalogues (a) of the Colliau foundry cupolas, with illustrations, lists of sizes and partial list of users, including twenty educational institutions in all parts of the United States; and (b) of Byram's foundry ladles, either hand, buggy or crane, of sizes from 1,000 to 35,000 pounds capacity.

The Carlisle & Finch Co., Cincinnati, Ohio, U. S. A.=Handsome catalogue A of searchlight projectors, adapted for land or marine use. Details of the reflector arrangement and of the special form of arc lamp are given, and illustrations and price lists of the several forms.

The Jeffrey Manufacturing Company, Columbus, Ohio, U. S. A.=Mining department catalogue No. 16, illustrating and describing coal mining machinery operated by electricity and by compressed air. A variety of machines for under-cutting, shearing and drilling are shown, as well as electric locomotives, pumps and other appliances for use in connection with coal mining.

Clayton Air Compressor Works, New York.=Complete catalogue No. 10, filled with handsome illustrations of the various types of Clayton air compressors, adapted to be driven either by steam or belt. Tables of dimensions and capacities are given, and much useful information relating to the production and application of compressed air.

Jenkins Brothers, New York.=Catalogue 1899, of improved Jenkins valves and fittings for steam, water, oils, acids or gases. A great variety of globe, straight-way and angle valves are listed, and a variety of back-pressure valves, check valves and special steam appliances.

Pierce, Butler & Pierce Mfg. Co., Syracuse, N. Y., U. S. A.=Very handsome large catalogue of steam and hot-water boilers for house heating, showing various types adapted for different purposes and forming a most effective presentation of an important line of devices for the purpose.

New York Central and Hudson River Railroad, New York.=Four-Track Series, handsomely illustrated folders, setting forth the attractions of various portions of the country reached by the railroad, including fine maps and instructive descriptive matter. Folder No. 26 contains a reprint of "A Message to Garcia," a little brochure which originally appeared in "The Philistine," and which has been much sought after since the exhaustion of the original edition.

THE
ENGINEERING MAGAZINE

VOL. XVII.

JULY, 1899.

No. 4.

ENGLISH AND AMERICAN LOCOMOTIVE-
BUILDING.

By Charles Rous-Marten.

IT is not at all wonderful that a considerable sensation should have been caused by the publication of the fact that four English railway companies—three being of the first class—were ordering locomotives from American builders.

Some forty years have elapsed since a British railway company went abroad for engines. The last occasion, so far as I am aware, was about the year 1859, when MM. Schneider et Cie., of the Creusot Works, France, received a contract for building a number of single-driver express and four-coupled fast-goods-train engines for the Great Eastern Railway. Many of those engines were at work until a few years ago, and I believe all turned out well. That, however, was wholly a special occurrence, and even at the time it made some stir. Hopes were freely expressed that a British railway company would never again go outside Great Britain for its engines.

It has always been a tradition stoutly held in England that, if there be one thing more than another as to which Great Britain enjoys absolute supremacy, it is in railways and in the construction of locomotives. Other countries, it is admitted, may do well in these respects up to a certain point, but then it is found that there are counterbalancing drawbacks which leave the English products supreme in excellence. Naturally, then, it came like a thunderclap upon these patriotic spirits to learn that the Midland Railway Company had ordered twenty engines from the United States. When the news next oozed out that the order of twenty had been expanded to thirty; that the Great Northern had followed suit by ordering a batch of twenty; and that the

Great Central had gone and done likewise, while, even the little Barry Company had added its small order to the big ones—then indeed a feeling of despondency almost approaching despair—a “glory departed” sort of sentiment—seemed to settle down over the land.

At any rate, that is the impression that might reasonably be obtained from a glance over the newspaper comments. And this state of feeling was even enhanced when the fact of the Atbara bridge contract also being obtained by America, became generally known. If England could not build locomotives for her own railways, or bridges for the territories conquered by her army, her case must indeed be a sorry one. Thus ran the prevalent course of comment.

A great deal of insufferable nonsense has been talked and written on the subject. I am bound to say that some of the English journals have been the chief offenders in this respect, the American papers, so far as has come under my notice, taking a far more rational and common-sense view of the case. It was alleged, for example, in one British paper, that the reason why American engines were ordered was that they are “much more powerful than English ones.” I am certain that Americans will be the first to laugh at intolerable twaddle of this sort. To educated readers I need hardly say that power is virtually a question of dimensions and material. Tractive force is obtained by the same proportionate dimensions in America as in England. That there are differences in *design* is unquestionable. But this is due to the fact that the methods of the two nations differ widely, and so the respective designers aim at the attainment of different objects. This view, however, I shall expand farther on. It will be better that at the outset I should make quite clear *why* these engines, seventy in all for the three great companies, have been ordered from America at an aggregate cost of about £200,000.

Now, it is the practice of the large British companies to build for themselves as many as possible of their own engines. But in times of exceptional prosperity when traffic crowds upon them at a faster rate than they can conveniently dispose of it, the resources of their own works are overtaxed and they are obliged to go to private firms for the additional locomotives needed. In the present instance the great wave of improved trade and general prosperity which happily has swept over the British Islands during the past few years has brought about such a rapid and voluminous augmentation of traffic that in spite of the utmost activity at the Derby, Doncaster, and Gorton Works, the Midland, Great Northern, and Great Central Railways found it impossible to supply on the spot so many new engines

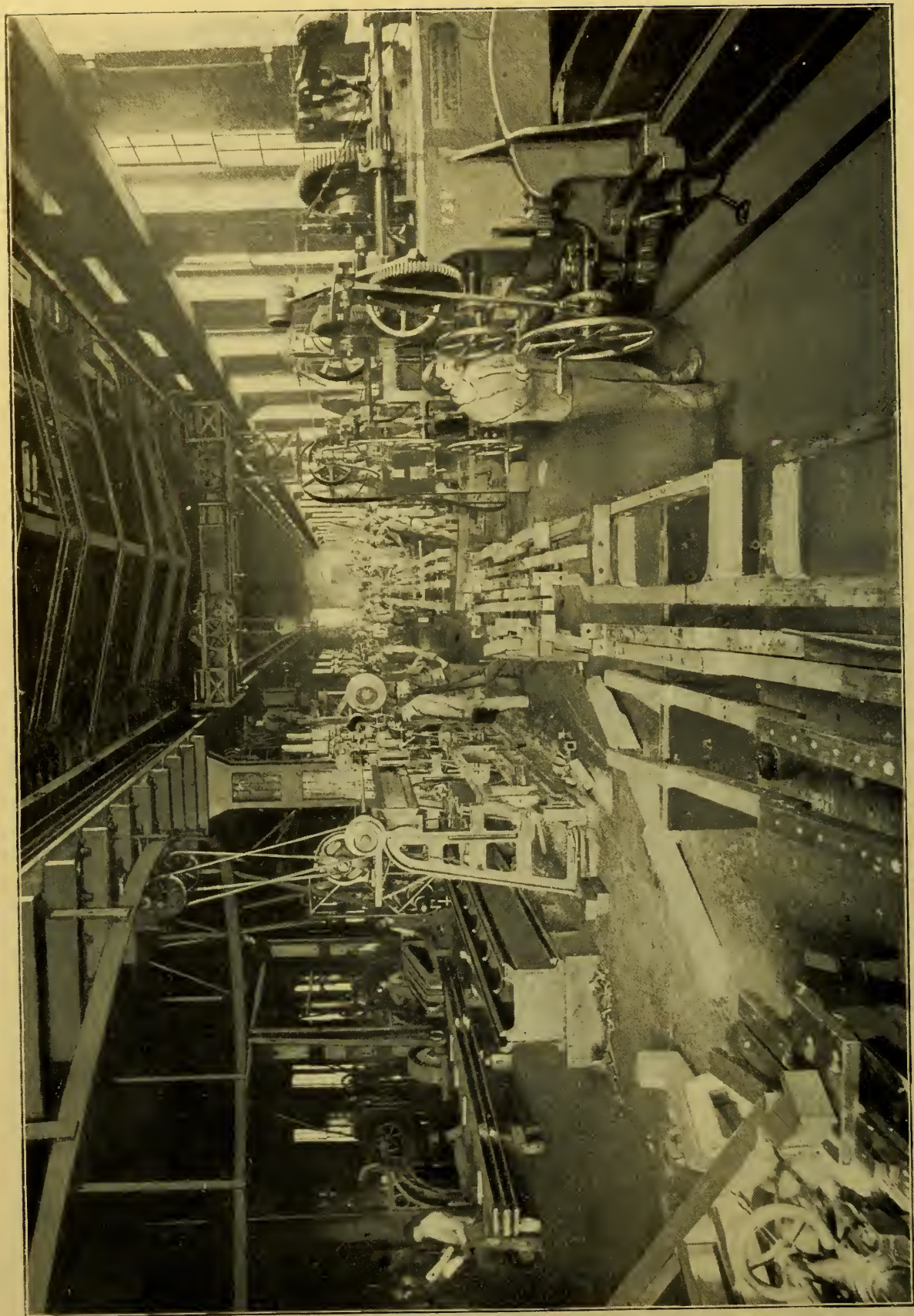
as were urgently needed. On the Midland, indeed, the existing goods engines, when they came into the shops for repairs, had to be turned out without being properly painted, a hasty coat of plain covering paint being all that time could be afforded to give them.

Thus it became necessary to seek the assistance of private builders : but, on application to the eminent firms that had previously supplied what was wanted in this way, all the three railways learned to their consternation that the press of orders was so great as utterly to preclude the acceptance of fresh contracts unless a year and a half or two years, or even more in some cases, could be allowed for fulfilment.

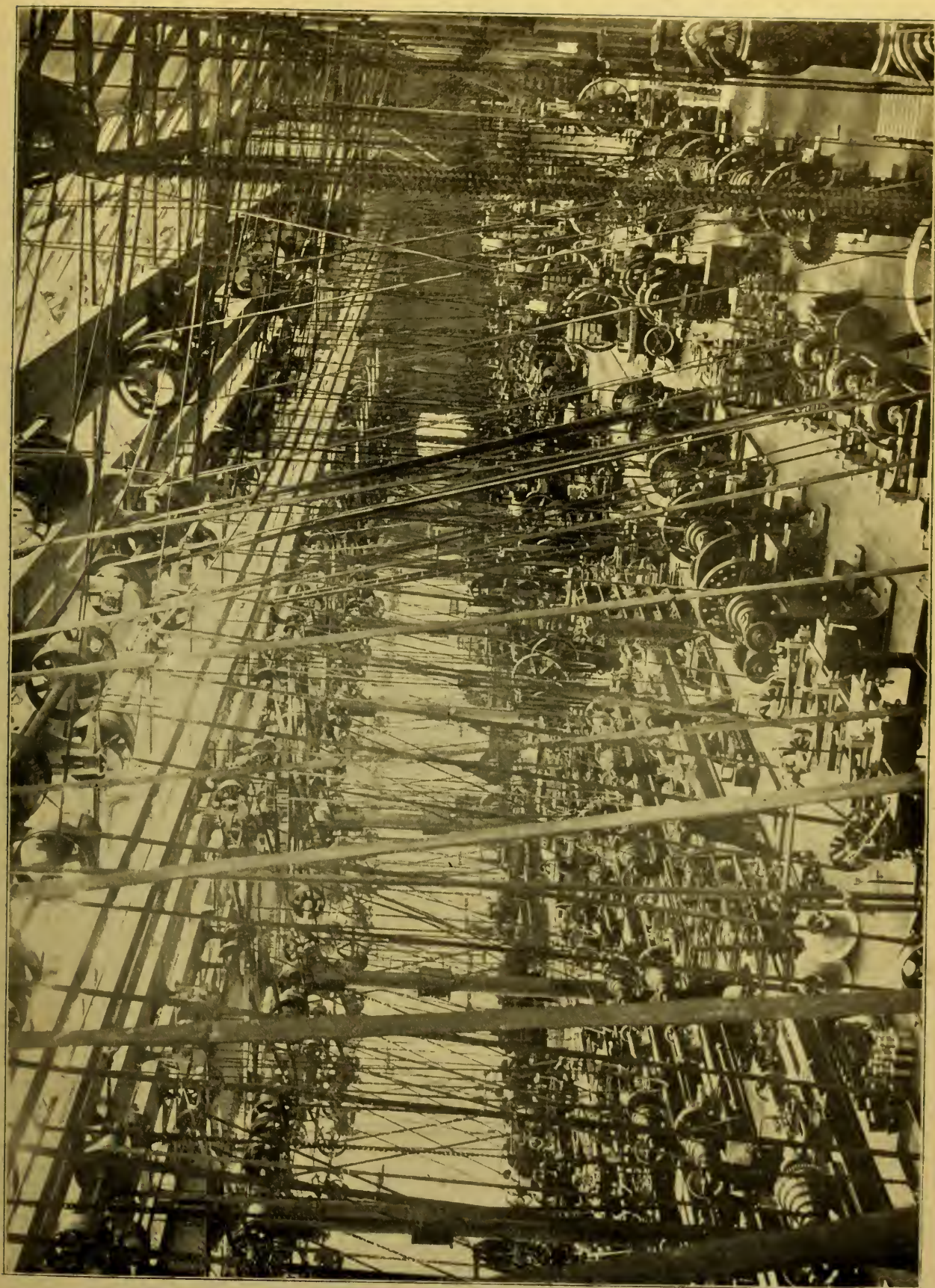
This was cold comfort to the traffic-overloaded railways. The need of additional engines was urgent and could not be postponed. Immediate recourse to other sources of supply was imperative. And so the contracts were entered into with Messrs. Burnham, Williams & Co., of the Baldwin Works, Philadelphia.

The engines ordered were in all these cases for the "goods" or "freight" traffic. They were required to be of an effective power equal to that possessed by the standard goods-engines in use on the three lines, of which drawings and dimensions were duly forwarded to Messrs. Burnham, Williams & Co. But the builders were authorised to construct them according to their ordinary practice, except for certain details to be mentioned later. That is to say, the goods-engines to be turned out at the Baldwin Works were to be freight-engines of the regular American type, modified only in respect of a few details. Messrs. Burnham, Williams & Co., having all their materials and parts and templates ready to hand, have been able to furnish the engines with a celerity that has seemed astonishing and almost incredible as compared with the customary way of British makers, and to unthinking or uneducated minds the contrast has suggested a number of conclusions, all transparently fallacious.

There have been many comments, for instance, on the strangeness of the fact that all the British builders should be thus overwhelmed with work just now. But this is the direct and obvious outcome of the engineers' strike of 1896. That most foolish and wrong-headed and mismanaged struggle cost both masters and men untold millions of direct loss, and sowed the seeds of consequential losses that operate now and must spread over many years still to come. One of the effects has been this present accumulation of arrears of work which has caused orders to the value of some £200,000 to be sent abroad, all of which is virtually kept out of the pockets of British workmen through their own insane action in the past. Again, it has been re-



VII
VIEW IN MACHINE SHOP, BALDWIN LOCOMOTIVE WORKS. TOOLS DRIVEN BY INDEPENDENT ELECTRIC MOTORS.



VIEW IN MACHINE SHOP, WORKS OF THE MIDLAND RAILWAY, DERBY.

marked as strange and blameworthy that the British makers should be less able than Americans to undertake an urgent order of this character at a moment's notice. This reflection arises simply from ignorance of the respective systems in force, a point to which I shall devote some subsequent attention.

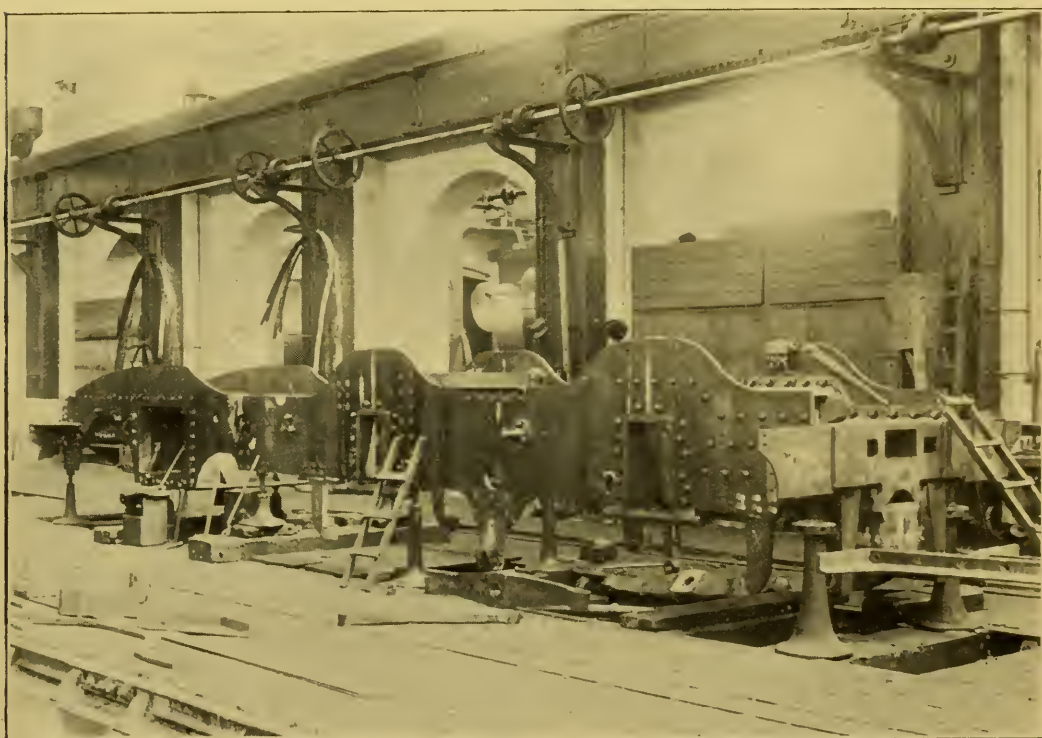
A third silly comment takes the form of a reflection upon the alleged blundering and lack of foresight exhibited by the English railway companies in not perceiving, a couple of years beforehand, what a sudden and heavy pressure of traffic would come upon them and what an accumulation of work would render British makers unable to provide the additional engines that would be required. It is difficult to treat seriously such a theory as this. It is of course put forth on behalf of the manufacturers, who have been accused of deficient enterprise exhibited in allowing America to secure these English contracts. Certainly it is not offered by any of the leading British engine-builders; for its absurdity is self-evident. No sane locomotive superintendent would move his locomotive committee to ask the directors for a vote of money to enable a large number of engines to be built or ordered in excess of present and prospective requirements, and if this were done, the shareholders would make it exceedingly warm for the directors and officers at the next half-yearly meeting. The executive authorities of British railways endeavour, so far as may be, to adjust their appliances as exactly as possible to the requirements which have to be satisfied, and this rule applies not only to the number of locomotives ordered, but to the capacity of the engines themselves.

It is a reproach often brought against British railway engineers that their engines have no margin of power; that they are built to perform a certain duty, and that should the onerousness of that duty be increased, even in a small degree, the locomotive cannot perform it, but must have the assistance of a second engine, or "pilot."

Now at this stage I have arrived at one of the main *principles* which affect the present situation. Here we reach one salient point of difference between the methods of Great Britain and of the United States. The American locomotive engineer deems it advisable to design his engine with a very large margin of power. If an express engine is designed to take a 200-ton load at 50 miles an hour, and if that load should happen to be increased to 300 tons, the locomotive is still expected to be able to take it and keep time, and usually does so. Such, at any rate, is the experience of such an impartial and level-headed observer as Mr. W. M. Acworth. If an American

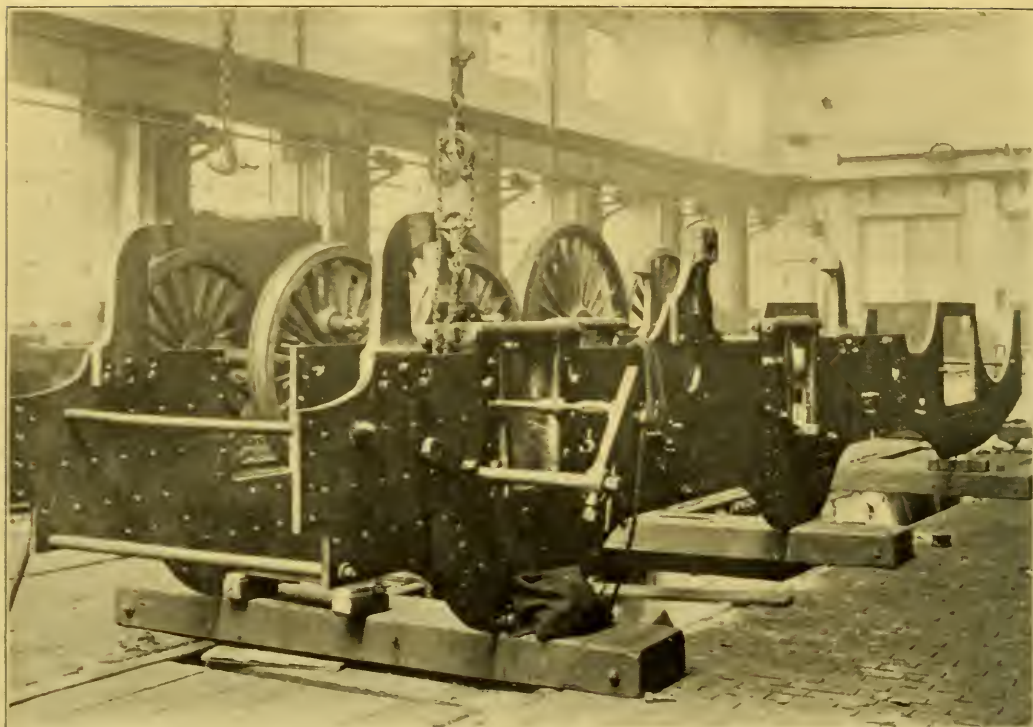
express be late at one point of its journey, the engine is expected to make up the lost time even if the load be larger than usual. And, again, this is generally done.

But if an English engine is given a single coach above its prescribed load, the driver at once insists upon having a "pilot," and commonly he gets one. Or should the weather be bad, with strong side-wind or a slippery rail, he demands an assisting engine and is accorded one, as a matter of course. Obviously this applies especially to the case of single-wheelers, which are so largely used on some English railways, because their range of power is much more sharply de-



LOCOMOTIVE IN COURSE OF ERECTION, L. & S. W. WORKS, NINE ELMS.

limited by adverse conditions than is the case with coupled engines. But in either case it seems indisputable that a smaller range of power is given to an English locomotive than to an American. It has long been a subject of criticism on the part of myself and other independent writers that the engines designed for some English lines are so manifestly deficient in respect of the power required as to render it a certain foregone conclusion that they will need extensive and frequent assistance by "pilots." When larger cylinders have been used, giving a great increase in the nominal tractive force, these have been coupled with a boiler no larger than that employed to fill the smaller



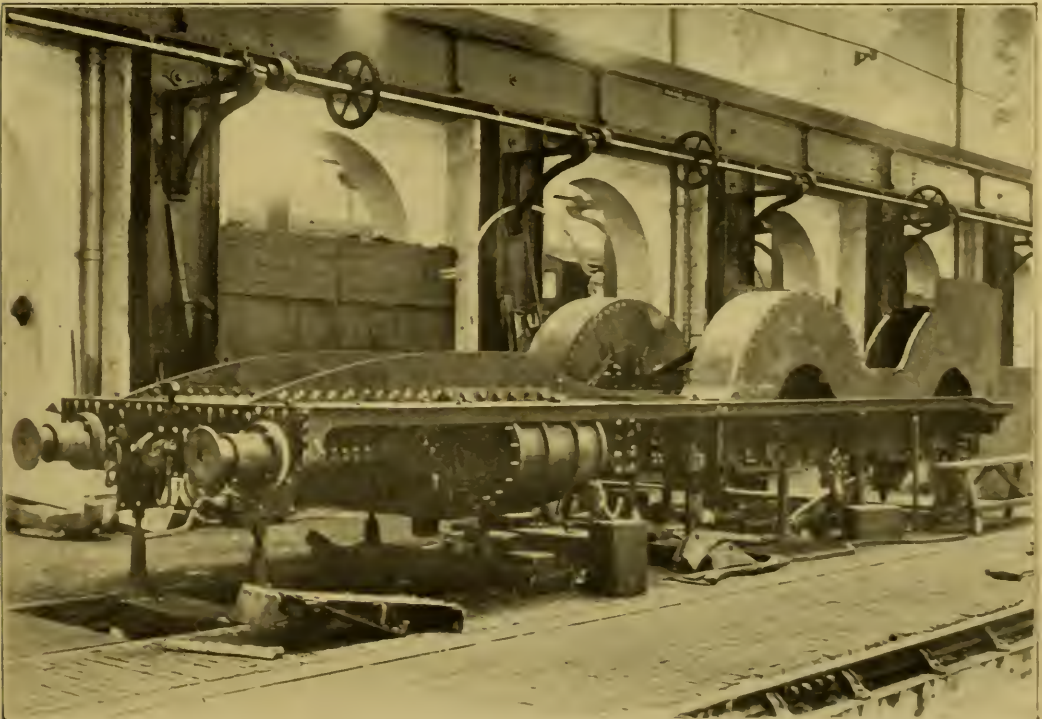
LOCOMOTIVE IN COURSE OF ERECTION, L. & S. W. WORKS, NINE ELMS

cylinders, with the result that enough steam is not supplied to enable the larger cylinders to do their full work. Thus two classes of engine employed in fast and heavy express work have only 916 and 980 sq. ft. respectively of heating-surface. Another, with cylinders $19\frac{1}{2} \times 28$, has only 1,031 sq. ft. In the United States, engines with similar cylinder dimensions and designed for similar duty, would have at the least, 1,800, 2,000 or 2,200 sq. ft. Nor is this difference explainable by the theory that a smaller heating-surface is, by more judicious disposal, made to do the duty of a larger area less favourably disposed, for the boilers referred to are small in all respects and assuredly have no margin whatever as a reserve to fall back upon in case of need.

It has been argued, in defense of this method, that there is no economy in building an engine which will not have its full power called upon during a considerable portion of the year, and that it is more economical to build an engine exactly suited to normal needs, which can be assisted by a pilot when loads are heavier or other conditions more unfavourable. It is not my present purpose to analyse the question or to discuss the merits of either side of the case. I simply desire to present a clear idea of the conditions which have to be satisfied in British locomotive designing. The engine has to fit its

known work. If a heavier train than normal should have to be hauled, the remedy adopted is either to divide the train or to employ a second engine.

In appraising the force of this view it must of course be borne in mind that the conditions of railway work often differ largely between England and America. In the former country all the chief main lines have at least a double track and even a quadruple one. In America some of the most important lines are single-track roads. Obviously, in this latter case, the urgency of clearing the way with all possible speed is so great that it has to be a paramount consideration in designing a locomotive that it shall have such ample power as to reduce to a minimum the duplication or multiplication of trains. So we find that American engines, for express and freight service alike, are planned and built to exercise, in emergency, enormously greater power than would be available in the case of an ordinary British engine. In the latter case the limit of loads is conditioned further by station and siding accommodation. The late Mr. Patrick Stirling, on the Great Northern, and Mr. William Adams, when on the Great Eastern, both tried the experiment of building goods-engines of greatly-increased power, the former having cylinders 19 x 28 and the latter 19 x 26, with six 58-inch or 60-inch coupled wheels.



LOCOMOTIVE IN COURSE OF ERECTION, L. & S. W. WORKS, NINE ELMS.

But the types have not been perpetuated because, although the locomotives could haul far heavier trains, these trains could not be handled conveniently, and so nearly all the extra power and cost were wasted. Therefore the later engines built for freight service have, as a rule, only $17\frac{1}{2}$ to 18-inch cylinders, and do all that is needed in existing circumstances.

Here then we perceive the folly of the allegation, made by certain English writers, that the new engines have been ordered from America because "American engines are more powerful than British." The new engines are not intended to be more powerful than the British locomotives with which they will work in regular turn. They have been ordered merely as equivalents. The English authorities build, as a rule, less powerful engines than do the Americans because they deem augmented power per locomotive unnecessary and regard the



BALDWIN ENGINE BUILT FOR THE MIDLAND RAILWAY.

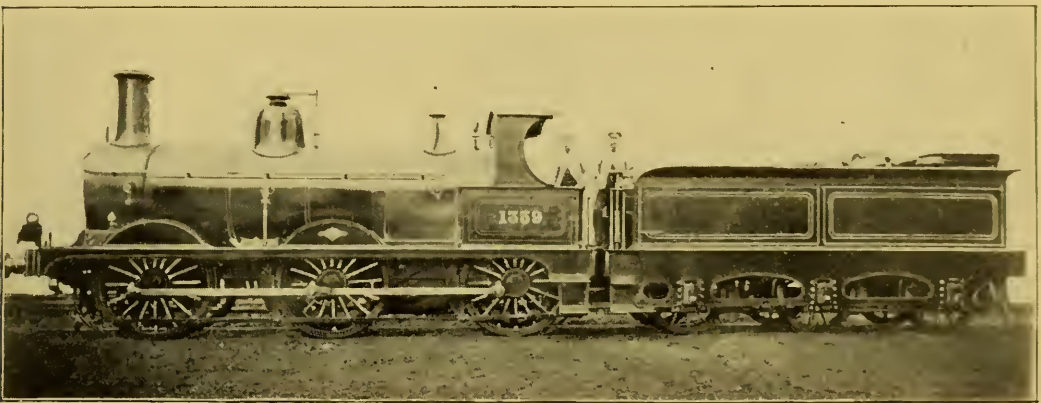
extra cost incurred in obtaining such augmented power largely in the nature of waste. In this view they may be right or wrong, but the fact nevertheless remains that the British engineers do not build more powerful locomotives "because they don't choose." It would be easy to do it but it is not thought expedient.

On the other hand, the advantages possessed by the American plan of having abundant boiler-power and a good margin of tractive strength seem to be coming more and more into recognition in Great Britain, so far as express work is concerned. All the most recent designs provide largely augmented boiler power and higher steam pressure. And it is tolerably certain that this tendency will continue and will increase rather than diminish.

There is, however, a condition which closely affects the designing of British express engines, as do the limitations of siding space

and hauling facilities that of freight locomotives. The awkward 4 ft. 8½-inch gauge cramps locomotive designers in America as well as in England. But in America the designer can spread outward beyond the rails almost as far as he pleases, and he can build upward to a height of 15 ft. 6 in. for the top of the smoke-stack above the rail-level. In England, however, lateral extension is sternly limited by the high platforms, and vertical extension by the heights of tunnels and bridges; so an English locomotive must not stand higher than 13 ft. 6 in. to the summit of its chimney. It is but just that this differing condition should be borne well in mind in appraising the relative features of British and American locomotive designs.

A further point of difference between British and American locomotive-building principles consists in what I may call the prognosis. "An American engine is at its best for only ten years and is an old

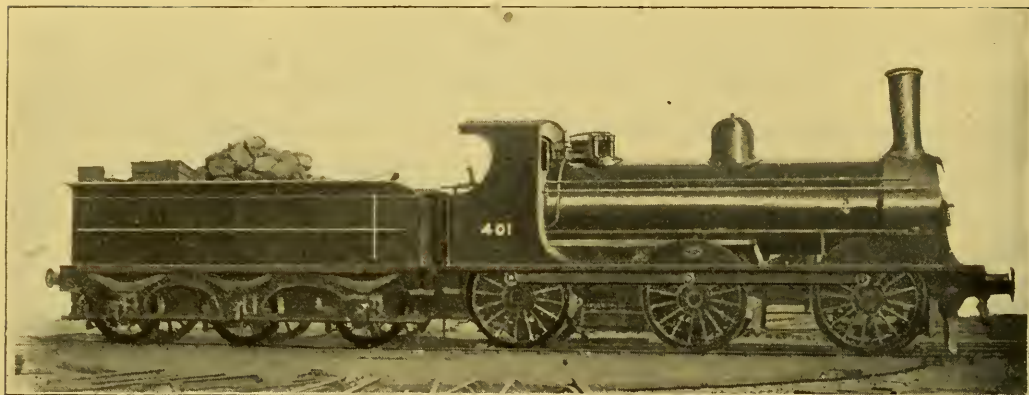


STANDARD GOODS ENGINE, MIDLAND RAILWAY.

(The type with which the Baldwin engines will work interchangeably.)

engine at fifteen years," said one eminent British engineer to me recently: "My engine will be good for thirty years or forty if required." On the other hand: "My engine will last for ten or fifteen years," said an American engineer to me, "and I wish it would not last so long, for it will be old-fashioned, if not obsolete in type, long before then."

Here you have, formulated in striking contrast, the two different principles. It has been remarked by a brilliant American writer that even the small bridges over ditches or tiny brooklets are built in England to last for centuries. The same idea pervades British locomotive designing. Curiously enough, the American principle of "doing things too well" in respect to power-provision prevails in Great Britain with regard to durability, the American practice being reversed. An express engine which was built so long ago as the year 1847 is at



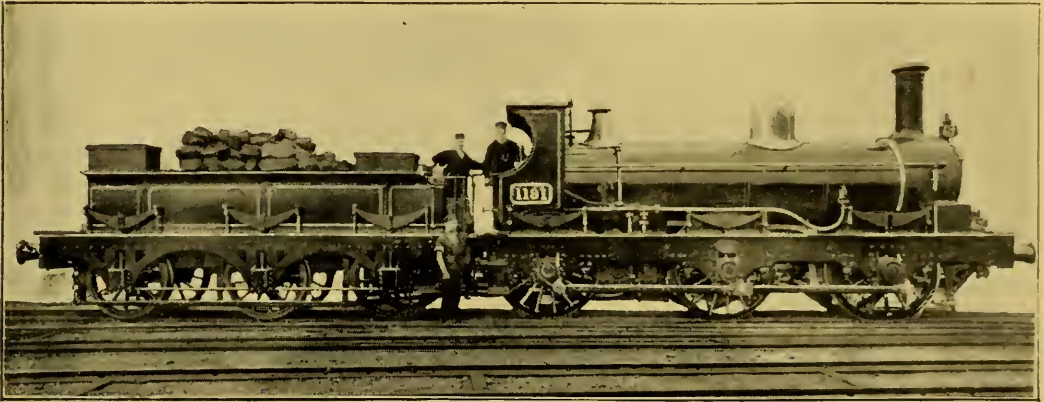
STANDARD GOODS ENGINE, LONDON AND SOUTHWESTERN RAILWAY.

this day working fast expresses in England. Numbers of engines built in the early sixties are yet at work and doing well. True, all have been repaired so extensively that they have become almost new machines. Still, I do not think I err in asserting that all would have been broken up and replaced by absolutely new engines fifteen or twenty or twenty-five years ago, in America. A slave owner is accredited with the saying that "It doesn't pay to take care of slaves and make them comfortable or to nurse them when ill; it is much cheaper to *use them up and buy new ones!*" That sentiment—atrocious in its application to sentient beings—is nevertheless one which may formulate a very sound policy in engineering. American policy is opposed to tinkering up antiquated and perhaps obsolete locomotives, in order to save the cost of new ones. English policy is opposed to throwing away engines which are still capable, when repaired, of doing useful service. Yet many a British locomotive superintendent devoutly wishes that some cataclysm of nature would sweep away finally all his old engines, thus leaving him free to bring in those having the



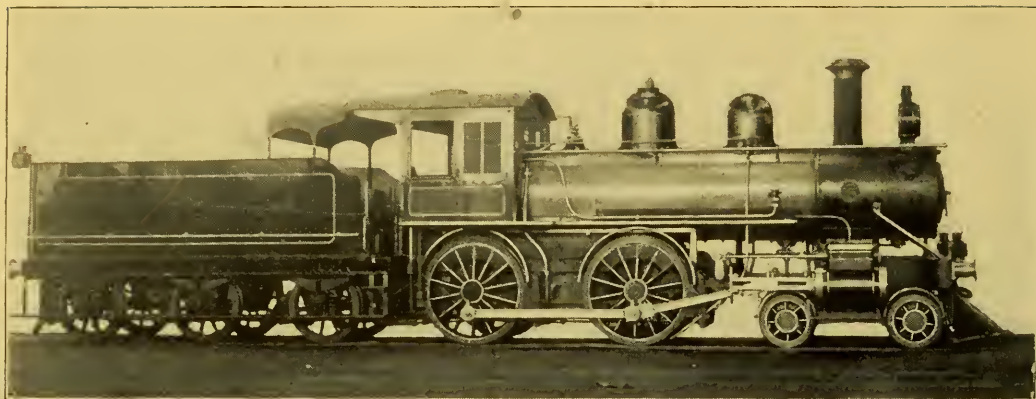
STANDARD GOODS ENGINE, GREAT NORTHERN RAILWAY.

modern improvements. Indeed, so strongly is the desirableness of this course felt by one eminent locomotive engineer—who, moreover, is famed for his economical administration—that he has sent to the scrap-heap nearly every engine of a date prior to his own advent some fifteen years ago. And the wisdom of the course is amply justified by the results. Yet his new engines are designed in their turn to last many years, and doubtless also in their turn to be voted obsolete at some future date. But the American tendency appears undoubtedly to build engines more cheaply, not intending them to last until they shall have become obsolete, or to outlive their day; also to get as much work as possible out of them while they do last—"use them up and buy new ones" is the theory, and it must be confessed that it has much to recommend it from a practical viewpoint.



STANDARD GOODS ENGINE, GREAT WESTERN RAILWAY.

It is, no doubt, imagined by some people, who unconsciously are tinged with the British idea, that engines constructed only to last ten or fifteen years must necessarily be defective—made of inferior material, or badly constructed—therefore must be less trustworthy than the more durable Britishers. But this is an error. Here again let me quote a British engineer: "The work in the American engines," he said to me a few days ago, "is good enough to serve its purpose and that is all. The builders know just what is absolutely needed and that is done, and no more. There is none of that extra finish and minute delicacy of work that we put into an English engine, and," he continued, after a moment's thought, "upon my soul I don't know why there should be, so long as the engines serve their purpose." And this, it is admitted, they do. But it at once becomes plain that this demand for excessive fineness of finish in detail is another respect in which the British makers are handicapped.



BALDWIN ENGINE BUILT FOR THE BENGAL CENTRAL RAILWAY.

Neither can it be averred with absolute positiveness that the British method of making the boiler-tubes of brass or copper and the fire-box of copper, instead of both being steel, as in the United States, gives results commensurate with the cost involved. As to the superiority of these materials employed in Great Britain, there is, of course, no doubt whatever. The question is: Are they so much better as to be worth the additional expense? Much may be said on both sides, but probably the just view is that each fits in best with the national theory of construction. Nevertheless, the insistence on copper fire-boxes and brass upper tubes is unquestionably one marked difference between English and American methods and has to be taken into account in any attempt to estimate relative values. In the case of the present order, copper tubes and boxes were stipulated for by Mr. Johnson, and are being supplied accordingly.

At this point we arrive at another station on our journey. Having reviewed the salient considerations in locomotive *designing*, the next stage is to notice the difference in the British and American modes of locomotive *building*. It must be understood that in this instance I deal only with leading principles and salient features. Limitations of space necessarily preclude the possibility of my entering into minute items of detail. Also, it will be borne in mind that I refer solely to the private firms of engine-builders, and not to the locomotive workshops of the railway companies themselves.

I believe I am accurate in stating that the prevalent British method, in ordering a batch of engines from a private firm, is to stipulate that the engines shall have *a* dimensions, and *b* weight, and *c* steam pressure; shall be made of *d* materials, shall do *e* work, and shall be constructed according to the pattern *f*—each of the figures, etc., represented here by italic letters being minutely specified. Also, I un-

derstand that the usual American method is to stipulate that the engines shall do certain work and that the builders shall be held responsible for their doing it, but that otherwise the builders may construct the engines in accordance with their own patterns and style of build. That is to say, the two methods are in diametric opposition one to the other. In the English case the builders must build in strict accordance with elaborate specification down to the minutest detail, and sometimes are required to use materials or particular parts by some special maker whose name is specified. All this must be done, but still the engine as then built must fulfil all the prescribed requirements. And I am bound to add, in the great majority of cases it does so. In the United States the great principle of responsibility on the part of the contractor is carried to much greater lengths. "Build the engine as you please," he is virtually told, "so long as you supply us with an engine that will do the work stipulated." And here again, the result is usually entire efficiency.

It needs but few words however, to demonstrate in what a different position the manufacturer is placed by the two systems. In America it is worth a builder's while to provide and keep always on hand the various parts of engines of several different degrees of power, and all the templates, etc., secure in the certainty that there will be a demand for each, sooner or later. In Great Britain it would not pay a locomotive-builder to make these preparations, for he would not have the slightest reasonable certainty that any one of them would ever be of any use. Railway companies never order engines from private firms if they can help it. They infinitely prefer, for numerous reasons, to build their own. And so private engineering firms have no inducement to lay down costly plants and to provide expensive parts and materials. No doubt a few of the wealthiest and most



BALDWIN ENGINE BUILT FOR THE BURMA RAILWAYS.

famous British firms in this way of business, such as Neilson, Reid & Company; Dubs & Company; Beyer, Peacock & Company; Sharp, Stewart & Company—to mention a few of those best known—do hold themselves always in readiness for locomotive building, because they have always some work of this kind in hand for foreign or colonial customers. But even in these cases, only the machinery can be established *en permanence*, because if a British railway ordered any engines, the order would, to a dead certainty, involve the special making of each working part and also, probably, provision in the specification that some particular maker's tubes, etc., shall be used.

But when a "foreign" customer goes to an American builder and stipulates for an engine to be built of a certain power and delivered within a limited period, he is well aware that the American builder will say to him: "O yes; I'll build your engine and deliver it in the time named and it shall do what you require; only I am not going to be hampered by all these minute specifications as to makers, etc. Tell me what you want the engine to do and I'll guarantee it shall do it, but you must be content to have it according to one of the patterns which I have already in stock. Of course as to a few minor details I'll meet you, so far as I can, but if you desire an engine at that price and in that time you must take what we have."

Thus, the prevalent system does undoubtedly hamper British engine-builders in respect of colonial orders. The British colonies find it much simpler and more satisfactory to telegraph to Philadelphia, "Send us immediately twenty locomotives of class X in your catalogue," or "a locomotive that will take *a* tons up a grade of *i* in *b* at a speed of *c* miles an hour," than to prescribe every detail and take the risk of the result. I remember a case very much in point which occurred several years ago. A British colony ordered of an eminent English engineering firm twenty engines, ten express and ten goods, which were urgently needed and for which elaborate and minute specifications were forwarded. There happened then, as now, to be a press of work on, and if my memory be accurate the builders required eighteen months for the execution of the order. At last the first two were sent out, accompanied by the intimation that, through compliance with the other specifications, the engines were obliged to be made each ten tons heavier than the weight limit permissible.

Naturally this caused some consternation in the colony, as it involved such extensive strengthening of every bridge over which those engines had to pass as to amount to virtual rebuilding. In the

correspondence which ensued it was made clear that the builders were not in fault for the error which had occurred. But meanwhile the shortage of locomotive-power had become a serious inconvenience and so, losing patience, the colony telegraphed urgently to an American firm to send out a dozen engines, express and freight, of the power and principal dimensions specified—*i. e.* of wheels, cylinders and weights. Those engines were landed within five months of the date on which the order was despatched, and cost £400 apiece less than the price of the British-built engines. They did all that was required of them and turned out satisfactorily in every respect.

Meanwhile the two British engines already sent out remained useless for a lengthened period, while negotiations were proceeding between the Colonial Government and the builders. In the end it was agreed, that the colony should accept the first two and undertake the alterations required to reduce their weight to a safe point, while the builders similarly altered the rest before shipping them. Whether the unfortunate locomotives that had to be thus cut and hacked about and whittled down "all over the shop," would turn out so well as their £400 cheaper American rivals may be left to the imagination of any educated reader.

I need hardly say that this experience resulted in an absolute cessation of orders from that colony to British builders. Strangely enough, while the influence of Imperialism and Diamond-Jubileeism was at its zenith, the same colony did endeavor to place a locomotive contract in Great Britain, but on learning that, owing to the pressure of orders, this one could not be executed for about a couple of years, the Colonial Government promptly transferred its custom to the United States.

Here then we see the respective conditions which prevail in Great Britain on the one hand and in America, on the other, as regards locomotive building. I have endeavored, as an entirely independent and impartial outsider, to present a strictly fair view of the case. If I have erred, it has been through inadvertence. I have refrained from expressing any opinion as to the relative merits of the rival systems and their fruits. Nor do I pretend to assert that the general rules of practice to which I have referred have no exceptions. But I have treated the situation as it is found to exist in ordinary experience.

In a future article I shall deal with a fresh phase of the question.

THE INCREASING PRODUCTION OF GOLD.

By H. M. Chance.

THAT the gold output of nearly every gold producing country has in recent years been rapidly increasing is well known, the total output of gold reported from all sources having, according to the best attainable figures, risen from an annual output in 1890 of \$120,475,300 to \$201,292,265 in 1895, and to about \$286,218,954 in 1898. As the statistics of gold production in this and other countries are accessible in governmental publications, and as the newspaper, periodical and technical press also frequently furnish such information, by re-publication and otherwise, it is not proposed to discuss here the relative rates of increase in production in different parts of the world, nor to indicate the probable relative future importance of any particular districts.

In an article published in 1896 in the May number of this magazine, entitled "The Present Value and Purchasing Power of Gold," the writer indicated certain reasons why the large increase in output, now noted, should be anticipated, and invited attention to the consequences of increased production, accompanied by decreased cost of production, as sure to produce a corresponding decline in the purchasing power of gold which would be indicated by increasing prices for all commodities.

Apparently at that time the tide had not turned, and gold had much greater purchasing power than had marked its value for many years; but within the last two years the decline in its purchasing power has been marked by the rapidly advancing prices of other commodities.

In that article attention was directed to the fact that ultimately the value of all commodities must be measured by the cost of production, and, that, while improved modern methods had effected large reductions in the cost of producing gold as well as of all other metals, gold had not declined in value, although other metals had so fallen; and that the prices of these other metals measured in gold units of value were abnormally low. Therefore a readjustment of values was to be anticipated, gold falling (or other metals rising) until each ruled in value at the average cost of production.

Some of the reasons why gold values respond sluggishly to re-

duced or increased cost of production were pointed out in that article and need not be repeated here.

It is the intent of the writer to take up the subject as it stood in the article of May, 1896, anticipating what has partially now been realized; to add to it the record of the last three years, to note certain new factors which have intruded and with which we must reckon in any attempt to forecast the future relative value of gold.

For a year past the financial world has been experiencing symptoms indicating rapid fall in the value of gold. These symptoms are, "easy money," "low interest rates," readiness to loan on collateral not formerly considered "gilt edged," and absence of any tendency to "hoard gold," willingness to subscribe to new bond issues, whether governmental or corporate, advancing prices for all classes of bonds and stocks and, most important of all, enhancing prices for nearly all commodities, for mineral, agricultural and manufactured products.

Politicians, and at times political economists, are prone to ascribe such changes to a "restoration of confidence," to peace, or to war, or to a "speculative craze," failing to recognize an underlying cause which impels such movements, producing the "confidence," producing the speculation.

And this cause, world-wide in its influence, making and unmaking values from generation to generation, producing great speculative opportunities to those capable of foreseeing them, is found in the fluctuations in the *cost of producing gold* and other commodities.

If the cost of producing wheat or iron or copper or wool is reduced by one-half, what is clearer than that the market price will fall correspondingly? So it is with gold also; but a decline in the value of gold is marked only by a corresponding increase in the market value of other commodities.

In the article above mentioned it was shown that the cost of producing iron, lead, zinc, copper and silver had declined largely in the preceding twenty years and that the purchasing power of these metals had declined from 44 to 52 per cent.; that the cost of producing tin had not been reduced as much as these other metals, and that its purchasing power had declined but 30 per cent. in the same period.

It was pointed out that the cost of producing gold from refractory ores had declined largely, but the cost of producing it by placer mining had declined very little; and as the world's store of gold had come principally from placer mining, and as the percentage of the total production coming from refractory ores had been small, that the

small stream of more cheaply produced gold from this source had not, up to that time, depressed the value of the large mass into which it was flowing; but that this gold of cheapened processes was rapidly coming to form a large percentage of the whole output and must inevitably bring the value of the accumulated supply to the level of the present cost of production by modern improved methods.

The writer believes we are now experiencing that change. How far it may go is difficult to foresee, but attention may profitably be given to some facts that will indicate whether it is likely to run its course quickly or slowly.

Whenever any industry becomes more profitable than others, many new workers are induced to engage in it, and as the great purchasing power of gold, co-existing with reduced cost of producing it, has in recent years made gold mining more profitable than most industries, large numbers of progressive men have become miners of and searchers after gold. Capitalists have been found ready to invest large sums in developing gold mining properties and in building the necessary mills and reduction works. The rapidly increasing production and the constant discovery of new mines and mining districts in all parts of the world are direct results of these conditions. That these factors will continue operative for a number of years seems probable, because such movements usually continue, by reason of the momentum gained, after the cause which set them in motion has ceased to act.

We may note further that, while in 1895 it was true that the cost of working placer gold "deposits had not materially been cheapened in the last twenty years," and that "the cost of producing gold from placer workings has remained practically unaltered by recent inventions," it is now necessary to modify these statements materially, because in the last three years it has been sufficiently demonstrated that many gold placers may be worked at low cost by steam power or electric dredges or shovels.

In almost every gold producing country are found gold placer deposits that cannot be worked by the ordinary methods of placer mining, but many of which may be cheaply and effectively worked by steam shovels or steam dredges. The successes recently achieved in working such deposits with these improved appliances bring within reach almost incalculable stores of gold, and from this source we may confidently expect a large and continually increasing addition to the world's output.

As capital, quick to find opportunities for profitable investment,

is already seeking dredging propositions in almost every country known to have river placer deposits, the gold produced by this method of working placers will doubtless soon become a factor of importance in the total yield.

During the last three years no further marked change has occurred in the cost of producing gold from refractory ores, but the limitations of the cyanide and chlorination processes have become better understood and their field of usefulness correspondingly enlarged, for both these processes are now so well known that it has become a simple matter to determine which of either process can be successfully used in treating any given ore; and this assurance, which the expert may now offer regarding these processes, often results in the speedy building of a mill which at once enters the ranks as a regular producer.

Three or four new processes, two of them electrolytic, are rapidly approaching the commercial stage and give promise of effecting further reductions in the cost of working refractory ores. If successful they will render large bodies of low-grade ores (worthless at present) available, which must add largely to the world's gold output.

The discovery of new gold districts and the development of new mines and deposits in old districts will probably be actively prosecuted for a number of years. Activity in this direction when once fairly inaugurated may generally be expected to continue for a considerable period.

From this source therefore we may look for large additions to the output of gold. New gold fields may and doubtless will be developed in British America, in Alaska, in Siberia, China, Africa, Australia, South America and various parts of the tropics; and new discoveries of importance in old mining districts, adding largely to the output, may be anticipated as long as the present active search for gold continues.

The production of gold may therefore be expected to increase steadily for a number of years from the following sources:

1. Enlargement of existing plants;
2. Discovery of new gold fields;
3. Discovery of new deposits in old districts;
4. Development of low-grade mines discovered in the past but unworked because of high cost, but now worked because of better and cheaper processes, cheaper materials and transportation;
5. Working of placer deposits with steam shovels and dredges;

6. Increased production of copper, lead and other ores carrying gold;

7. NOTE: The exhaustion of old mines is probably more than offset by the ability to mine cheaply at much greater depth.

While such a continuance of the present rapid increase in the production of gold appears probable as will carry the annual output of gold far above any figures or estimates yet made, no fears need be entertained that this flood of gold will cause a disastrous decline in its value or purchasing power, for it may always be confidently remembered that the value of gold, as of other products, is determined by the *cost of producing it*. In the last twenty years the cost of producing gold has fallen probably from 30 to 50 per cent., but, as the cost of producing most other metals and other staple commodities has similarly declined, the relative value of gold and other products has not suffered much change. Nor does such change appear probable, for there are no inventions or new conditions in sight promising any further large reduction in the cost of producing gold that would not similarly affect the cost of producing other staple commodities.

As suggested in the article before mentioned, in 1896 the prices of iron, copper, tin, lead and zinc were abnormally low; the purchasing power of gold abnormally high. A readjustment has occurred: lead, zinc, tin, iron and copper have rapidly risen in price, and on all sides one hears expressions of opinions indicating a general belief that this rise in value is abnormal; that it is due to artificial and not to natural conditions, and that while a moderate advance in the price of metals was justified by the economic and governmental conditions of this country, that the increase in price is greater than these conditions would naturally effect. And supplementing opinions of this nature is the very common belief that present prices cannot be maintained for any considerable period. Those reasoning in this way base their belief upon a conviction that the rise in metal values is due principally to "restored confidence" in the future of this country, to a period of activity with increased consumption naturally following the period of depression through which we have passed, and to a natural reaction from what were generally recognized as abnormally low prices; *i. e.*, prices actually below the cost of production or too near the cost of production to afford a living profit.

This line of reasoning largely ignores the fact that the advance in values reaches far beyond the limits of this country, is world-wide in fact, and therefore cannot be attributed to restored confidence in the future stability of the government of this country.

While restored confidence with corresponding increase in consumption of metals for structural purposes has doubtless hastened the readjustment of values, it does not seem possible that such large and general advances in market prices could have occurred except by reason of the flood of cheaply mined gold which is being added to the world's store.

The great speculation in copper mining stocks and in copper mining properties is eliciting much discussion, and many fear disastrous results from the collapse or reaction which they regard as inevitable. If the position here taken is correct no such result need be feared regarding the successful dividend-paying copper properties, although unwise inflation of the values of unproductive properties—of mere “prospects”—is always to be deplored. For, as compared with gold, copper should certainly be intrinsically worth 15 to 18 cents per pound as measured by the relative cost of producing the two metals notwithstanding the fact that 10 or 11 cents has been the ruling price for several years. The writer would draw the same general inference with reference to other metals, and believes that the continuance of the increase in the output of gold will justify the maintenance of prices from 50 to 75 per cent. higher than the abnormally low prices reached during the recent period of depression.

With advancing civilization, extending, by sword and cross, rapidly year by year over those countries inhabited by the barbarous or semi-civilized nations, must come rapid increase in the consumption of and demand for all metals. This alone may be a strong factor in the maintenance of prices for all metals, but, more important still, a large percentage of copper, lead and silver ores carry also notable quantities of gold, so that any large increase in the output of these metals must add largely to the annual production of gold. The increase from this, source, therefore, promises steady future growth, irrespective of that due to increased activity in gold mining proper.

The opening of the Trans-Siberian railway, the completion of the great North and South road through Africa, and the industrial development and railroad building in South America, open to civilization vast regions in which gold may be found and which ultimately must be the scene of extensive mining operations. English and French capitalists have already engaged American experts to examine the Siberian provinces for promising gold deposits in anticipation of the possibility of profitable mining when cheap transportation is assured. Russians, Frenchmen and Americans are now exploring the Northeastern Siberian provinces and report extensive areas of

gold bearing territory. Peru, Bolivia, the U. S. of Colombia and Brazil are being scoured by hundreds of English and American prospectors and investors for gold mines; Western Australia is likewise being searched from shore to shore, and in South Africa the prospecting of new regions never ceases. These added to the Arctic fields (the climate of which the miner no longer fears) promise an immediate and continuing increase to the present large annual output of gold. In almost every district old mines are increasing their output, and formerly abandoned or unworked mines are becoming regular producers.

Another reason for anticipating further increase in the production of gold is found in our better knowledge of gold ores, and of the conditions under which gold occurs in nature. Until the discovery of the Cripple Creek district, the occurrence of gold as tellurid in deposits of large extent and value was practically unknown. Gold was, of course, known to occur, sparingly in some ores, partially as a tellurid associated with other minerals; but such a mineralized belt as that at Cripple Creek was entirely unknown, and such deposits were not looked for by the prospector.

Similarly, we now know of another class of gold ores in which the gold occurs apparently in some form chemically combined in a silicious matrix, often approaching a true jasper or hornstone, and showing by analysis possibly 95 per cent. of silica. Such ores show no trace of "free" or metallic gold, and the presence of gold can be determined only by assay or analysis. A few such discoveries have recently been made, accidentally, by inexperienced persons who had rock assayed from curiosity.

Similarly again, in the last few years, gold has been found in most unpromising looking porphyry dykes—the very rocks prospectors the world over have regarded as necessarily barren because they almost invariably fail to show any "free" or metallic gold by the miner's quick "horn" or "pan" test.

But mining engineers and prospectors are learning that in a mineralized region gold may occur in any rock, and hundreds of prospectors are assaying all sorts of most unpromising looking rock, satisfied that by assay alone can they determine whether a certain rock is gold bearing or not.

This persistent and more or less systematic work now going on in every mining district must result in the discovery of many valuable deposits in unexpected localities, and ultimately promises to add largely to the annual output of gold.

THE WORK OF THE NAVAL REPAIR SHIP VULCAN.

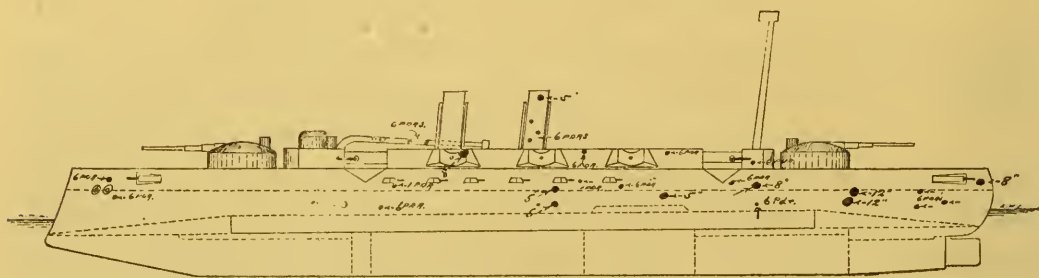
By Gardner C. Sims and Wm. S. Aldrich.

WHEN Admiral Sampson left Guantanamo Bay, 10 A. M., Sunday, August 14th, 1898, almost immediately after the signing of the protocol, and sailed north with the battle-ships, the first work of the mission of the *Vulcan* as a naval repair ship had been fulfilled. The efficiency of the fleet in Cuban waters had been maintained. The vessels of the Eastern Squadron for a naval demonstration off the coast of Spain had been fitted out and repaired in foreign waters, in a time of war, without recourse to a navy yard. The remaining work ahead consisted of minor and miscellaneous repairs, changes, alterations, etc., of vessels of the auxiliary navy and a few of the regular service making Guantanamo Bay a naval base. This was to be followed, after their being raised and floated, by overhauling, repairing and fitting out the former Spanish vessels, the *Sandoval* and the *Infanta Maria Teresa*. In this interval the character of the *Vulcan's* repair work was radically different from that executed before the protocol. It now partook of the nature of regular navy yard work, in times of peace, with much more of routine fitting out work than that considered necessary for the well-being of a fleet in war time.

The former Spanish gunboat *Sandoval* had been scuttled and sunk in the head waters of Guantanamo Bay, off Caimanera, by her treacherous Spanish captain, to prevent her falling into the hands of the Americans. On Sept. 1, the *U. S. S. Marblehead* and *U. S. S. Potomac* succeeded in raising the *Sandoval*, and the following day she was brought alongside the *Vulcan* for overhauling, repairing and fitting out. The same evidence of Spanish treachery and vandalism was to be seen in this little 100-ton gunboat, as in the case of the *Cristobal Colon* and the *Reina Mercedes*. Sea valves were opened, dead lights were broken in, and on every hand was ample evidence of an attempt to so injure the vessel that, should it be raised, it would be of little use to anyone. The copper feed pipe which had been battered and cut by an axe, was repaired on the *Vulcan*.

Aside from the work for the steam engineering department of this vessel, a very large amount of work was executed for the equipment

and the construction departments. The engine-room telegraph was overhauled, the whole motive-power machinery of the 137 horse-power triple-expansion engines was taken apart, cleaned, repaired and put into service; boilers were overhauled and repaired; and weak and corroded side plates forward were replaced by new ones, after the *Sandoval* had been beached on the shore by the Playa del Este. We



INFANTA MARIA TERESA

(Showing approximate locations of hits and probable sizes of projectiles.)

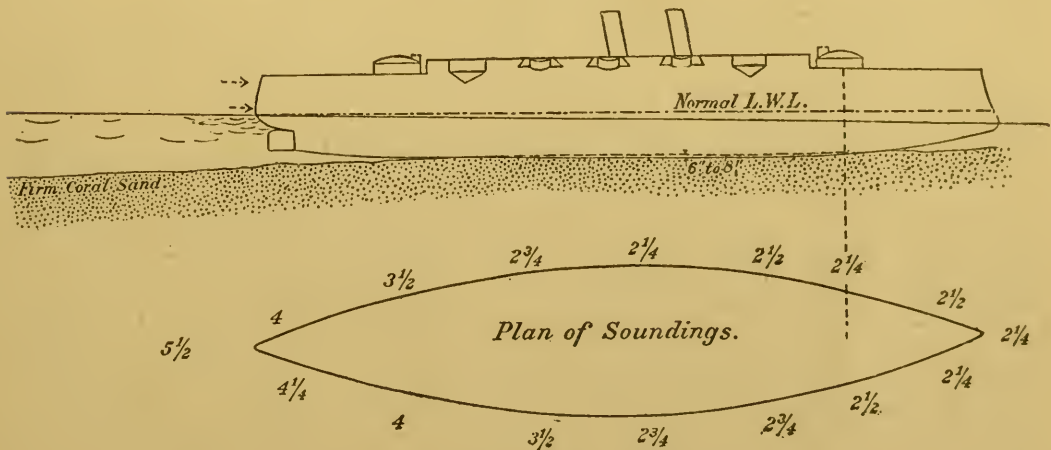
were confronted with the English or Whitworth system of threads in all cases of repair work executed for the Spanish vessels, as well as for the English-built vessels like the refrigerating ship *Glacier*.

The Spanish armored cruiser *Infanta Maria Teresa* was constructed in the works of the Martinez-Rivas Palmer Co., at Bilbao, Spain, in 1890-91. These works were operated under the control of the Spanish government, after their failure, and placed under the personal supervision and directorship of Admiral Cervera. This vessel, the sister ship of the *Almirante Oquendo* and the *Viscaya*, was 364 feet long over all, of 65 feet beam and 38 feet depth of hold, of 7,000 tons displacement and a mean draft of 21 feet 6 inches. She was protected at the water level by a 12-inch armor belt, on each side, extending 315 feet and rising 5.5 feet vertically, with 12 inches of armor around the conning towers, 8 inches of armor around the ammunition tubes, and from two to three inches of protective decks. There were two 11-inch Hontoria guns, one each in forward and after turrets, mounted *en barbette*, under 2.75-inch spherical canopy and behind nine inches of armor plate. Five 5.5-inch rapid-firing Hontoria guns were mounted on each broadside within the citadel, with twenty other guns of various calibres. There were eight torpedo tubes in all.

The twin-screw cruiser *Infanta Maria Teresa*, on her trial trip made 18.5 knots per hour on natural draft, developing 9,560 indicated horse power. On the forced-draft trial trip she made 20.2 knots per hour, developing 13,760 indicated horse power. Her coal capacity was 1,050 tons, giving a steaming distance of 9,000 miles at a ten-knot

speed. The full complement was 484 officers and men. Throughout the whole of this ship there was installed the latest and most approved complete system of voice-pipe arrangements. Chadburn's patent telegraph signalling system had also been installed, as in our own naval vessels. Admiral Cervera having personally supervised every detail of construction of this fine armored cruiser, there is no wonder that when he made his famous sortie from the harbor of Santiago he selected this vessel as his flagship instead of the Italian-built armored cruiser, the *Cristobal Colon*.

At 9:35 A. M., in the morning of July 3, the *Infanta Maria Teresa* steamed out of the harbor of Santiago at about a 10-knot speed; and five minutes later, at about 4,000 yards range, actively engaged the American vessels. At 10:15 she was seen to be on fire, and heading for the beach, the firing from her guns having ceased. The early destruction of all of the most approved means of communication and the blocking up of all passage-ways by the rapidly-spreading flames made it impossible to command further the movements of the ship as a fighting machine. Forty-five minutes to silence and throw out of action a most modern war vessel, furnishes precedent for the

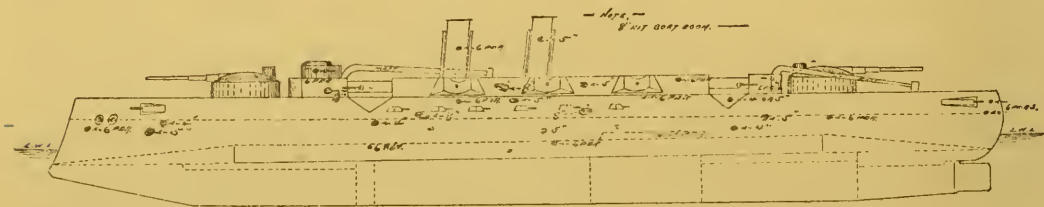


INFANTA MARIA TERESA AS BEACHED.
(Soundings in fathoms)

conduct of naval warfare which Admiral Colomb of the British Navy speaks of as being "terribly business-like on the American side."

Admiral Cervera, in his report to the Spanish Minister of Marine, states: "There could be no doubt as to the outcome, but I should never have believed that our ships would be destroyed so rapidly." He then shows that the first shells which the *Maria Teresa* received resulted in the bursting of an auxiliary steam pipe and of the water mains, the enemy's fire producing terrible injuries, and destroying the

chief elements of defense as well as the net for protection against fire. The explosion of another shell set fire to his compartments, which spread with great rapidity, and was joined by other fires, the result of similar shell explosions. Sufficient water could not be obtained to keep the flames under control. Orders were given to open the valves in the after part of the ship to flood the magazines but it was impossible to do so. Dense clouds of smoke prevented passage through the ship below deck, and Cervera's instructions could not be carried out. "In this situation," he states, "I could only think of beaching the ship, and did so. The contest was impossible on our side. I thought to lower the flag, but that was not possible on account of the fire, which prevented all operations." She was headed for the beach, west of



VIZCAYA.

(Showing approximate locations of hits and probable sizes of projectiles.)

the Punta Cabrera, only six miles from Santiago harbor, and stranded at the same moment that the engines stopped.

From an examination of the wreck it is evident that about the *Infanta Maria Teresa* the fire of the American ships began to concentrate with most telling effects. The vessel was hit about thirty-three times, above the exposed waterline. An 8-inch shell struck the shield of the second 5.5-inch gun on the port broadside, passed through, ranged aft, and exploded with terrific effects. Another 8-inch shell struck the gun deck, under the after barbette, passed through and exploded, ranging aft, tearing and ripping the beams in its path, and greatly damaging the longitudinal bulkhead between the two cabins, and cutting the fire mains. Two 12-inch shells entered just under the berth deck, through almost the same hole, "keyholing," as it is called, exploded in the stern torpedo room, cut the berth deck beams from the frame, completely wrecked everything in that compartment, and opened up a large ragged hole, about four feet square, on the starboard side. A 5-inch shell struck under the berth deck, ranged aft, passed through wing passage into coal bunker and exploded, setting fire to the coal.

Of all the wrecks the *Maria Teresa* had been the least damaged

above the water line. Torpedoes were found intact and magazines uninjured. Only the forward military mast and its fighting top came down with the weakening of its substructure, due to the intense heat of the fire in the fore part of the ship. It fell aft into the starboard gangway. The wooden bulkheads above the protective deck, the wooden deck-flat, and almost every vestige of wood above the water line was destroyed by fire. Admiral Sampson speaking of this feature states: "If the war teaches one lesson more than another it is to dispense with all wood in the future construction of our ships. Not a particle of it should be permitted where it is possible to avoid it."

The board appointed by Admiral Sampson to examine the condition of the Spanish vessels, sunk or destroyed, reported on July 13, 1898, after an examination made as complete as possible along the following lines: condition of hull and the practicability of saving the vessels; condition of ordnance equipment, magazines, etc.; condition of machinery and boilers; effect of gun fire upon the enemy's vessels. From this valuable report the following details are taken, of particular interest with relation to the *Maria Teresa*:

The vessel was found nearly upright, lying without appreciable angle of heel at a water line differing from the load water line by trimming about five feet by the stern. Flooding was practically complete fore and aft. The vessel rested easy, bearing upon the bottom throughout the greater part of her length. Soundings showed the bottom to be firm coral sand, shelving gently more or less. Diving within the hull was impracticable under the conditions.

The frames above water were practically intact, having only deformation more or less moderate, due to heat. The deck beams above water were generally more or less warped by the heat. They had sagged and dropped to such an extent as to destroy their structural usefulness. The stanchions had been affected in practically the same manner as the beams. The bulkheads above the protective deck were principally of wood. Those of metal—limiting the upper coal bunkers—were badly warped.

Generally speaking, the outside plating for structural purposes was considered intact. There was warping, though not pronounced, in the upper portions subjected to heat. Divers' reports showed an intact condition below the water as far as examination could be extended. All deck plating above the protective deck, including the stringers and tie plates, had been more or less warped and the fastenings impaired by the heat from the burning of the wooden deck-flat.

Taking full account of the distribution of weights and strains in-

volved, and of the reduction of strength as pointed out, it was in general considered that with an intact condition of internal structure below the protective deck the remaining structural solidity was adequate for the stresses liable to be encountered in wrecking the vessel or in any except severe conditions of navigation. Occasion was taken to point out that the vessel had suffered more as a longitudinal girder than as a transverse girder, and that in a heavy sea it would be on the side of security to avoid the position of steaming head to sea. There were no indications of any internal explosions having occurred on this vessel. All deformations found could be readily accounted for by the heat effect of the conflagration.

The engines were found covered with water to within six inches of the tops of the cylinders. From what could be seen it would appear that exploding shells had not struck them. There was no evidence in the approaches to fire rooms of any boiler explosions having taken place. The boilers, however, were subjected to extreme strains, due to sudden cooling. All the piping above the protective deck had been warped, melted and otherwise destroyed by heat.

The structural solidity of the ship was not to any considerable degree injured. Barring local distortions, the hull was found practically intact. The outside skin was reported by divers as intact so far as holes were concerned. The examination extended to the bilges, fore and aft, and, in some parts of the extremities, to the bottom. The board was therefore of the opinion that it was possible and desirable to float the *Infanta Maria Teresa*. The vessel lay in a very good position, with deep water astern to facilitate pulling her off, and fairly well protected against an easterly sea.

In order to lighten the *Maria Teresa* as much as possible, the wrecking company cleared out all store-rooms, lockers and compartments; removed the ten 5.5-inch guns, shields, etc., which were mounted, five on each broadside; removed the fourteen torpedoes and war heads, anchors and chains; and by direction of the commanding officer in charge, large quantities of foul, decayed and unhealthy stores were thrown overboard, with unsafe ammunition which had been condemned.

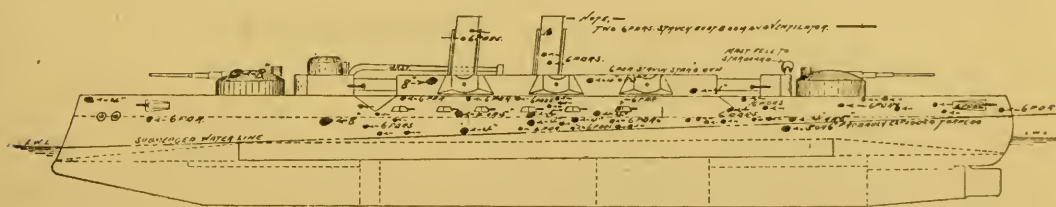
An attempt to float the *Maria Teresa* was made about the middle of August. It was to be by the so-called "quick-dispatch" method, consisting in closing all accessible holes, putting in enough pumps to control the leaks, hauling off, and towing to the nearest port for docking and repairs.

An unexpected influx of water occurred, having entered through

the leaks forward, and worked aft through a large number of openings, many of which were then unknown to the wreckers. Following this the water had risen inside to a level only slightly lower than outside. But it was considered safe to allow this water to remain till the large leaks forward could be located and gotten under control.

The method then followed was to locate and stop the leaks, largely from the inside. All efforts which had been made to stop the leaks from the outside had proven futile, the blankets, canvas, etc., being either carried away by the swell or sucked completely inside the ship. The approximate position of the leaks was determined and large pumps were concentrated on those compartments, while divers were kept steadily at work on the leaks. Four large pumps were kept ready for duty, being supplied by steam from the two donkey boilers of the *Teresa*, and from four portable donkey boilers put aboard by the wreckers.

Again, everything appeared to be in readiness for floating the *Teresa*. The first visit made to the wreck, Sept. 19, which found the



OOUENDO.

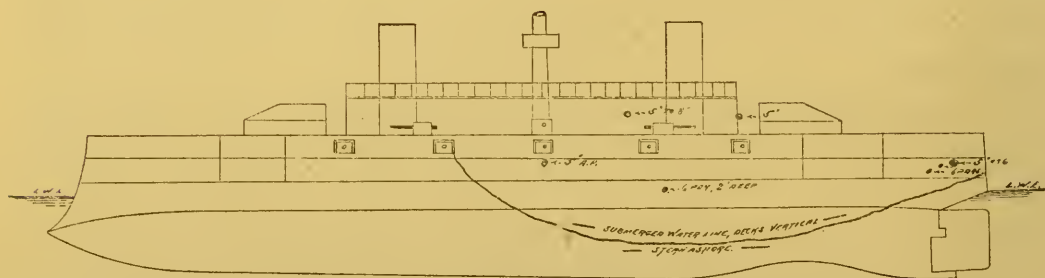
(Showing approximate locations of hits and probable sizes of projectiles.)

Vulcan lying to, in the heavy ground swell off the site of the wreck, by the shore of Minamina, with an engine room temperature at 110 degrees, and that of the fire-room at 140 degrees. The attempt to float the *Teresa* at this time, however, was not wholly successful. It had to be again postponed. It was evident that the wreck could be floated and taken in tow, but it was not deemed advisable to do so at that time. The *Teresa* had been practically floated and the ultimate success was now beyond question. There was a slight movement, with more or less swaying of the stem, but the wreck seemed still to be down by the head, and to require greater buoyancy at that point to place it on a more even keel.

At the same time the *Vulcan* placed a working party of chief machinists and helpers aboard the *Teresa*, with all necessary tools and supplies, to put the steering engine and gear in order, and do such other work as might be found necessary, preliminary to tak-

ing the wreck in tow, for Guantanamo Bay. This party remained on board till the *Vulcan* again visited the *Teresa*.

A second visit to the scene of the wreck was made on September 23rd. At 9:50 A. M., the *Infanta Maria Teresa* was successfully hauled off the beach amid the firing of national salutes and the blowing of steam whistles from all directions. She was taken in tow by the *U. S. S. Potomac* and the wrecking tug *I. J. Merritt*, with hawsers from the starboard and port bows, respectively. The flagship *Newark* and the repair ship *Vulcan* stood off close on the starboard and port quarters of the wreck, respectively. The former Spanish gun boat *Alvarado* and the wrecking tug *Chapman* followed on the starboard quarter, while the wrecking company's supply ship *Signor* and



CRISTOBAL COLON.

lighter followed off on the port quarter. The *U. S. S. Scorpion* stood off the tow and well in shore in order to indicate the location of selected beaches had such an emergency arisen as would make it necessary to beach the *Teresa*.

During the tow of the *Maria Teresa* to Guantanamo Bay the sea was quite calm for a while and all went well. After passing Morro Castle, at noon, a breeze sprang up, stiffening somewhat later on, bringing with it rain and heavy winds, making our progress very slow and somewhat hazardous. At times there seemed great probability that the *Teresa* might again be lost. Owing to the direction of the storm it was necessary to stand well off the shore. The *Teresa* would shear off alternately to port and to starboard and become almost unmanageable. Old-time sailors attributed all of this to the unlucky day of the week, the Friday selected for this work. Landsmen said that Cervera's pet cat on the *Teresa* was guying his pet dog on the *Vulcan*.

The *Vulcan* and the wrecking tug *Chapman* stood close by off the *Teresa's* quarters ready to run a hawser forward if necessary to steady the ship and assist in keeping the *Teresa* on her course. This was not done, however, notwithstanding the hazardous condition in which the

towing vessels *Potomac* and *Merritt* were very frequently placed owing to their short bow line hawsers. Guantanamo Bay was reached at 7:30 in the evening, and at 9:30 we came to a safe landlocked quiet anchorage far inside the offing, thenceforth to be known as "Teresa Bay." An earlier survey of this admirable anchorage had been made by the *U. S. S. Newark* and such a spot selected for the berth of the *Teresa* as would place her keel within easy reach of the divers when standing on the bottom of firm coral sand.

When the *Maria Teresa* had been safely anchored in Guantanamo Bay, a thorough examination was made, and Lieutenant-Commander Ira Harris, U. S. N., commanding officer of the *Vulcan*, reported on her condition as follows:

"Captain Chittenden, the wreck master in charge of the work for the wrecking company, agreed with me, as soon as a careful examination had been made, in considering five things as essential for reasonable safety in a passage from here to Norfolk:

"First. The holes in the bottom are all located in a space of about seven feet square, and should be secured by a patch on the outside, a cofferdam inside, and by making that compartment water-tight.

"Second. The main engines should be put in condition to steam in case of towline parting.

"Third. A spar deck strong enough to throw off any seas should be built between the two iron bulkheads on the bow and stern, the two bulkheads should be made tight, and all openings in the iron decks outside these bulkheads closed.

"Fourth. Sufficient control should be had of the pumping and drainage systems so that the safety of the ship should not depend on the wrecking pumps alone.

"Fifth. That the shot holes, broken parts, and other openings in the sides should be safely closed."

A camp was at once established by the shores of "Teresa Bay" for the hundred or more Cubans to be employed on the wreck. These men were secured from Caimanera, Guantanamo and vicinity, quartered at the camp, provided with rations from the *Vulcan* and other United States vessels, daily mustered and sent aboard the *Teresa* in charge of their own foreman. As large a detail as possible was made from the *Vulcan's* best workmen of all classes, and daily engaged in overhauling, repairing and fitting out the *Teresa*. An expense account of labor and material was kept for all work done on the wreck. An accurate daily log or journal of each day's work was written up, containing the number of hours of work of each man employed, his navy

rating and pay, the number of men employed, kind of work done, with a complete and accurate list of all stores or other articles supplied the *Teresa* from the *Vulcan*.

All efforts were exerted to make the ship thoroughly sea-worthy and the main engines and boilers serviceable with such work upon them as is usually found necessary to overhaul and repair submerged machinery. Brass castings were made to replace broken parts and for new gear, light and heavy forgings were executed and a great number of boiler plates were gotten out to cover the shot holes and other leaks in the outside plating. The dynamos of the *Teresa* were thoroughly



(By courtesy of Collier's Weekly.)

U. S. S. VULCAN AT SEA

The *Vulcan* is a single-screw steamer, 265 feet long, 40 feet breadth of beam, 26 feet depth of hold, with a load draft of 17 feet forward and 20½ feet aft, and a carrying capacity of 2,700 gross tons. The main engines are of the vertical inverted cross-compound condensing type, cylinders 40 and 70 inches diameter by 48 inch stroke with four main boilers, one auxiliary boiler, and a surface condenser with independent circulating pump. At 80 pounds' boiler pressure, and from 55 to 60 revolutions a minute, she attains a twelve-knot speed on a coal consumption of 25 tons daily.

examined and found to be utterly useless owing to grounds everywhere. The importance of light on the wreck is apparent during both its overhauling and conveying north.

The progress of the *Vulcan's* work in overhauling and repairing the *Maria Teresa* had so far progressed by Oct. 12th, that Lieutenant-Commander Harris reported of it as follows:

“(1) The outside patch is safely secured and so skillfully that the bow has raised 70 centimeters. To get at the space where the cofferdam must be made it is necessary to cut through the floor of the sail room, remove the sand, which to the amount of perhaps 60 tons has entered there, and cement and concrete several large breaks and bends. It is slow work removing the sand, which cannot be pumped and has to be carried by chains of Cubans with buckets.

“(2) The starboard main engine has been reversed this day by steam and will be worked in perhaps two days by steam. The port engine is perhaps four days behind.

“(3) The deck is nearly done. The after part is being roofed in for quarters. Bulkheads will be put in. Part of the bridge has been restored; a steering wheel put there, the steering engine put in running order, speaking tubes put in to the steering engine and to both main engines, and electric bells to call the engineers to the speaking tubes. A deck has been put over the iron deck forward to work the ship from.

“(4) The drainage of the ship is so complicated and has been so injured by fire and shells that it is difficult to follow out and control. The pumps now are nearly all in working condition, and by trial we are gradually finding what we need.

“(5) In addition to the shell holes and ports of all kinds, we have in the last day or two discovered that four torpedo openings were in a very dangerous condition. The gates had been so hot as to char the wood outside of them into mere charcoal, which fell from the bolts at a touch. Patches have to be riveted over all these holes.”

At sea, Tuesday, Nov. 1st, 1898, at 5:11 P. M., Lat. 24° 33' North, Long. 74° 35' West, about 45 miles N. N. W. from Watlings Island, the Spanish armored cruiser *Infanta Maria Teresa* was abandoned while in tow of the U. S. S. *Vulcan* and the Merritt-Chapman Wrecking Company's steamer *L. J. Merritt*, bound from Guantanamo Bay, Cuba, to Norfolk, Va., under contract with the wrecking company for safe delivery of the wreck at Norfolk for the sum of \$100,000. No lives were lost, all hands having been successfully transferred to the *Merritt*. The wreck was abandoned

with 16 feet of water in its hold, and supposed to be in a bad condition.

At 5:30 P. M., Saturday, October 29th, the *Vulcan*, having the *Infanta Maria Teresa* in tow, and with the *Merritt* assisting ahead, started to leave Guantanamo Bay. Owing to the length of the towing hawsers and size and difficulty of handling the wreck, it was 7:10 P. M. before we left the harbor and started ahead full speed. The *Merritt*, with 200 fathoms of 10-inch manila line fast to head bitts on the *Vulcan's* forward deck, led the tow. The *Vulcan* in turn was towing the *Teresa* with 230 fathoms of 15-inch manila line, made fast to a chain bridle which was secured to the bitts on each quarter and barked to the bitts in either gangway. The *U. S. S. Cincinnati* and *U. S. S. Leonidas* accompanied the tow, as convoys, taking position on either quarter of the wreck. The weather this night was fair, but bad weather was threatening, the moon being almost obscured by a thick mist. The barometer ranged from 30.05 to 30.09. All three ships behaved well in the head sea caused by the trade winds and made an average speed of six knots.

At 8:12 A. M., Sunday, Oct. 30th, Cape Maysi bore abeam, distant about three miles. Soon after, at 8:50 A. M., the *Cincinnati* left, making international signal, "A pleasant passage." All during the day the tow proceeded without difficulty towards Crooked Island Passage. The trade winds were fresh and the sea moderate, but the weather was damp, misty and cloudy, making sights difficult. A speed of 5½ knots was kept up without effort, the *Vulcan* steaming at 50 revolutions only. The *Leonidas*, under orders to convoy through the Passage, remained on the port quarter of the *Teresa*.

At 12:40 A. M., Monday, Oct. 31st, we sighted Castle Island Light and at 3:40 A. M., passed it abeam. At 10:30 A. M., Bird Rock Light House was also abeam. At 8:50 A. M., the S. W. point of Watlings Island was passed abeam, distant about three miles, and the vessels proceeded up the Crooked Island Passage inside the island. At 10:10 P. M., the light on N. E. end of Watlings Island was on the starboard beam, distant 10 miles, and at midnight it was broad off the starboard quarter bearing S. E. distant 15 miles, the ship's course was North. These data were obtained from a beam-and-quarter bearing to plot the position for a final departure. The weather was cloudy and misty all day, but the tow being under the lee of the islands and in smooth water made excellent progress, averaging a little over six knots. The *Leonidas* still continued as a convoy and kept her original position off the port quarter of the wreck.

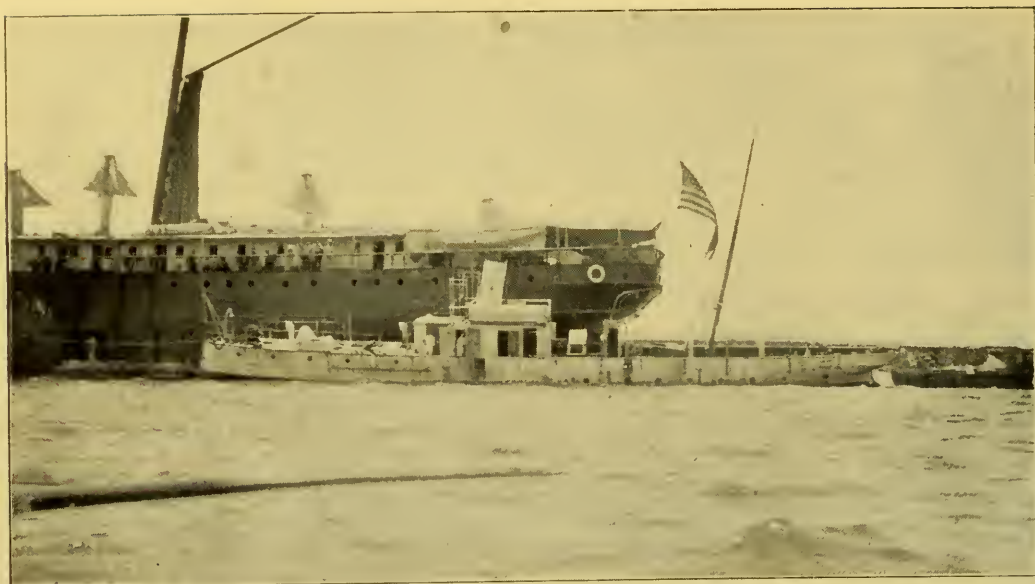
Tuesday, Nov. 1st, began cloudy, damp, misty and threatening. At 12:50 A. M., sight of Watlings Island Light was lost, bearing about S. E. by S., distant 18 miles. At 12:55, a heavy squall from the N. E. struck the ship. The wind and sea continued to increase all through the day with every indication of a cyclone, though the barometer remained high, and even rose from 30.06 to 30.24 at 8 P. M. At 2:45 A. M. the *Teresa* signalled the *Vulcan*: "Signal *Merritt* steer to windward." This was done and all changed course from North, to N. by E. $\frac{1}{2}$ E., wind and sea at N. E. Slowed down engines from 50 to 45 revolutions on account of high sea. Several times during the day the *Teresa* signalled to know the barometer.



POTOMAC RAISING THE SANDOVAL.

At daylight the *Merritt* and *Teresa* were both pitching and rolling deeply, the latter making heavy weather of it, plunging the bows under and burying the forward deck up to the turret. It was also noticeable that large quantities of water came out of the recesses around the hawsepipes in the bows, originally filled with wood but burned out by fire, and often, when rolling the *Teresa* shipped seas amidships. The *Vulcan* was riding easily but with engines racing badly. The tow lines of both were working perfectly, and no undue strain on lines or bitts was noticeable.

THE NAVAL REPAIR SHIP VULCAN.



(By permission of Collier's Weekly.)

SPANISH GUNBOAT SANDOVAL ALONGSIDE OF VULCAN.

The gale and sea continued to increase all during the forenoon, and it was obvious that the *Teresa* was in serious trouble. A message from *Teresa* to *Leonidas* was repeated several times, "Do not go so far ahead"; but the signal apparently was not understood. An answer was also signalled to *Teresa's* question, "What is direction and distance to Watlings Island?" the answer, "S. S. E. about 30 miles. At noon *Teresa* signalled, "Ask *Merritt* if she can run to Watlings Island safely." The *Merritt's* answer was "No." The *Merritt* immediately hoisted signal to the *Teresa*, "Give your orders." To this signal the reply was made to *Vulcan* and repeated to *Merritt*: "Cast off *Merritt's* line and have her come under our lee side. Have *Leonidas* stand by on our weather side, we are going to abandon ship." In obedience to the *Teresa's* signal the towline of the *Merritt* was let go at 1:50 P. M., and as they dropped off to leeward and into the trough of the sea it was to disappear entirely with the exception of the tops of two masts, they alone being visible. Three times by wig-wag and once by navy code the *Leonidas* was signalled but failed to respond. Finally, after rounding to under the *Teresa's* port quarter, and when abeam to port, at 2:40 P. M., *Leonidas* signalled, "What is the matter with *Teresa*?" The answer was, "*Teresa* is sinking and abandoning ship, has signalled you for assistance."

Meanwhile, all hands were called to assist the distressed ship, on which were 114 brave men, 44 of them belonging to the crew of the *Vulcan*. The *Teresa* now signalled "Do not cast off our line yet,"

to which reply was sent, "Will hold on to the last and assist you by using oil." They answered "Thanks." The officers of the *Vulcan* were all ordered to direct the work of active preparation that was to be made by way of reserve, and all the men responded with energy and ability to the tasks allotted. It was learned by signals that the *Teresa's* starboard engine was making 38 revolutions per minute; and it would doubtless be kept working until the last; as it was, the commanding officer of the *Vulcan* decided first of all to hold on to the hawser, thereby giving the *Teresa* sufficient steerage way to enable her helmsman to keep the heavy sea on her starboard bow, and still be to leeward of *Vulcan*, enabling the latter to use oil to advantage when rescuing the boats began.

From the first the heavy laboring of the *Teresa* gave the impression she would founder suddenly, and that all of her people would be overboard at any moment swimming or drowning. Everything was done, therefore, during the first hour with that thought uppermost. The executive officer was directed to take charge aft with full authority to cut away the tow line immediately it became apparent



(By courtesy of Collier's Weekly.)

SPANISH GUNBOAT SANDOVAL READY FOR SEA.

that the ship was actually foundering. He was given complete charge of all details regarding the work of preparation and succeeded so well that the *Vulcan* was ready for any emergency in a remarkably short time.

A call for volunteers, to man two life boats, made by Executive Officer Lieutenant W. W. Gilmer, U. S. N., was immediately answered by an ample force, and the boats were made ready for lowering fully supplied with water, bread and meat, also with lines, life preservers and oil and a crew of six men, three of them being chief machinists, to be commanded by Lieutenant Gilmer.

All of the life preservers were gotten up, inflated and distributed, ready for use in boats and life rafts, or to throw to people in the water. Two life rafts were equipped and lowered with long lines attached, and were dropped down to the wreck. These rafts did not reach the *Teresa*, but were blown away from her. One was hauled back, but the other fouled the towing hawser, capsized and broke adrift, drifting down past the wreck, but to the eastward of it, and out of reach, as the ships were not lying directly headed to wind or to sea.

Besides all of these preparations with the same end in view, a bowline was made in every rope's end, by which a man could be hauled out of the sea. Two six-pounder rifled rapid-firing guns were converted into life guns, for throwing life lines, by reducing the charges and utilizing part of a weighted oar with a line attached as a projectile. If the *Teresa* had foundered before her people had been taken off it was the *Vulcan's* commanding officer's intention, after letting go the chain bridle, to place his vessel to leeward and then work up to windward of the men in the water and pick them up by every possible means.

Oil, one of the first requirements, was used with marvelous effect. Machinists passed it up in buckets from the hold; those on deck filled small bags with it, which were towed astern. Oil was also fed through the bathroom and other drains. Immediately the breaking top of the wave disappeared and the seas near the wreck smoothed down.

After the *Teresa* began to fill it became impossible for the *Vulcan* to keep her head up to windward, but being partially waterlogged the *Teresa* made an excellent breakwater for the boats even after she fell off into the trough of the sea. During all the preparations that were being made, there was no noise or confusion of any kind, no running aimlessly about the ship, although each man must have known that his shipmates on the *Teresa* were about to be cast into the sea, and that soon to look out for his own

safety would be the best thing that could be done. In case the ship was ordered to be abandoned each man knew his boat and station on the life raft, although some of them had gone adrift, and sharks seemed to gather as if to prevent anyone from becoming a banquet for worms.

Fortunately, none of the preparations made was needed, as the work of rescuing the crew and volunteers was nobly done by the *Merritt* with the *Teresa's* own surf boats and crew. The *Teresa* had three of these boats, two of which fortunately were on the port side. Both were lowered, as was also a catamaran. The boat on



VULCAN'S FORCE AT WORK ON MARIA TERESA.
(View of after turret and deck rigging)

the weather side of the *Teresa* was not lowered, nor was the catamaran used. The part planned by the *Vulcan* in the rescue consisted in steaming ahead slowly and thus holding the *Teresa* up to the sea. By this means the oil, freely used, was distributed where it was most needed. At the same time the little headway given the *Teresa* enabled her officers, with helm hard-a-starboard, to keep the sea on their starboard bow, thus giving the rescuing boats a little lee, which was made safer by the efforts of the oil bags.

Their signals not to let go the line showed that the plan had their approval. At 2 P. M. the *Merritt*, splendidly handled by her captain, David Wolcott, "wore ship astern of the *Teresa*," and came up

under her lee just in time to take off the first boat of rescued men at 2:20 P. M. There were less than four hours of daylight left in which to rescue 114 persons, including 18 Cuban coal passers, and such a sea was running as would have daunted any lifeboat crew.

To have attempted to go near enough to the great ship's side to let her people climb down or drop into the boats meant certain destruction to the rescuing party, so while the boat was towed by its painter from the ship's lee quarter, and was kept clear by two men at the oars, and by the steersman at the stern, another line was used to send the men from the ship, and in this manner: The line was made fast on the *Teresa*, and in it were two bow lines. These the men placed around themselves just under their arms, and, taking their positions, waited for the ship to roll to port, and at the word of command jumped into the sea. To the other end of the line was made fast a modern ladder as a float. The men were then hauled through the water, in most cases, to the surf boat, and then tumbled in over the bow.

It was a slow but safe process, as the result proved, for by 5 P. M. every man of the 114 was safe on board the *Merritt*. Although only 230 fathoms of hawser separated the *Teresa* from the *Vulcan*, the watchers on the latter vessel, owing to the heavy seas and driving rain and spray, were only able to see the boats of the rescuing party at long intervals when they came out of the trough of the sea.

As soon as the first boat-load was landed on the *Merritt* the surf boat was turned off to a point well off the *Teresa's* lee bow, so that the boat's crew could pull in smoother water to her side. By 3 P. M. the second boat-load had been transferred, but it was evident that more boats were needed; and at 3:19 the second surf boat was lowered from the *Teresa's* lee side. Skillfully handled by her crew she cleared the ship without injury and was dropped back to the loading point just off the lee quarter.

The first boat lowered made in all four round trips between the *Teresa* and the *Merritt*. The second made three trips, so that to rescue all hands the boats had to make the passage through those heavy combing seas fourteen times, and right gallantly those brave fellows accomplished the work. Lucky indeed was it for those rescued that the boats were manned by "past masters at the oar and helm."

For two hours men with axes, under direction of the executive officer had been stationed aft, on board the *Vulcan*, ready to cut away at a moment's notice the lines that held the hawser in case the *Teresa* should founder at any time during the transfer of her men.

Every *Vulcan* man watched with an anxious eye the great ship as she plunged "forecastle—head under" the head seas clear to the turret, and came out again, the water streaming from her hawse pipes, and showing the heel of her beam above the next big sea. Forty-four shipmates of theirs were on board the doomed vessel, and it was yet a question whether their rescue could be effected before dark. Heavy rain squalls beat the seas down a little at this time, but the wind blew harder than ever.

Struggling for a foothold on the *Teresa's* rickety bridge, her signalman, Crosset, wig-wagged to the *Vulcan* at 4 P. M.: "Don't



VOLUNTEER CREW FROM VULCAN THAT TOOK MARIA TERESA NORTH.

cast off the tow-line yet; two more boat-loads will clear the ship." To this signal the reply was sent: "All right; will hold on until the last." High up on the bridge, silhouetted against the leaden sky, and bracing himself against the fearful rolling of the *Teresa*, as she wallowed in the seas, stood Moorhoff, of the engine-room force, at the wheel. He was alone, and the last person to leave his post, for it was not until the final boat was rescuing its quota of men that he lashed the wheel, came down the bridge ladder and went aft to leave the ship with his mates.

At 4:54 P. M. the last boat-load left the *Teresa* and was safely



EVENING SCENE IN THE VULCAN'S WARD ROOM.

rescued alongside the *Merritt*. Fearing that some might have been overlooked the tow-line was still held and the wreck searched with glasses through the rain and spray for some sign of life. By this time the wreck was low in the water and water-logged, shipping quantities of water with every sea and settling rapidly.

After making sure that the boats had finished their work of rescue and that all had been taken off, the *Vulcan's* engines were stopped, the hawser slackened, and finally, at 5:11 P. M., the order was given to cut away the tow line. Two blows of an axe severed the lines that held the chain bridle to the bitts on our starboard and port quarters, and as the links rattled out through the stern chocks three cheers were given as a salute to the Stars and Stripes flying in defiance of the elements at the *Teresa's* jack yard, and also to the bravery of the *Merritt's* men who had made such a gallant rescue of their ship-mates. Twenty minutes later it was so dark that the *Teresa* was only a black spot against the horizon, and at 6 P. M. nothing but the lights of the *Merritt* and *Leonidas* could be seen, while the gale howled and the sea rose higher than ever.

The *Vulcan* was then hove to, heading N. E. by E., with engines turning as slowly as possible. The *Leonidas* and *Merritt* did the same, but headed N. E., and the vessels remained in sight of each other near the wreck. At 7 P. M. the *Merritt* put her helm aport, steamed off and disappeared. The *Leonidas* was lost sight of on the port quarter about 9:30 P. M. Neither vessel made any signals and both seemed to be safe and in good condition. The gale lasted all night, moderating slightly about daybreak.

As soon as daylight came Wednesday, November 2, the *Vulcan* "wore ship" and steamed down a general S. W. course, zig-zagging across to pick up her consorts. The *Leonidas* was sighted at 6:50 A. M. heading N. E. She soon turned around, however, and joined



(Original negative by Mr. J. A. Scott.)

LAST VIEW OF THE MARIA TERESA.

Snap-shot taken from the stern of the *Vulcan* after the crew of the *Teresa* had left her. The *Merritt* is seen to the right.

in the search for the *Merritt*, following for about 12 miles. In this way it is believed that all the probable and possible ground over which the *Merritt* could have passed while "hove to" was thoroughly searched. It was hardly expected that she would be found, as it was believed that she had started for New Providence Channel or Nassau soon after dark to seek shelter and get rid of her large number of passengers. They reached Charleston, S. C., many of the men without sufficient clothing, some of them in their underclothing, and without shoes, stockings or hats. It was afterwards learned that the *Vulcan* had encircled the *Teresa*, and although lookouts were in the cross trees, on the bridge and forward deck, the rain and mist prevented the wreck from being sighted.

Criticism is easy and natural for those without responsibility; they do not even require facts on which to found an opinion. It has been asked if it would have not been well to have left a lighted signal on the *Teresa* so as to keep track of her during the the night. It would, but they did not have any lanterns, and the recent experience of the Hamburg-American Line steamer *Bulgaria*, from New York on January 28, for Hamburg, through continuous gales from February 5th to the 19th, sighted by three vessels, and twice towed by one of them, yet lost in the night to all of them, finally reaching the Azores, 800 miles distant, illustrates the uncertainty, after standing by a disabled vessel, of ever seeing it again.

At 8:15 A. M., November 2, the *Vulcan* steamed for the *Leonidas*, and signalled for permission to proceed. It was granted, adding: "We will stand by until 4 P. M., unless we sight them sooner." During the day the gale increased, and towards night gave every indication of developing into a cyclone. At 5:40 we were again "hove to" to watch shifts of wind. At 7:40 it was thought best to steam to the eastward to allow the storm to pass. The course was accordingly changed to E. N. E., but by midnight it was found the weather was not improving, so the course was again changed to North.

Fortress Monroe was reached shortly before midnight November 5, where the safety of the rescued men was learned. Next morning the *Vulcan* was ordered to the Norfolk Navy Yard, and on reaching there was informed that a steamer with two smokestacks was reported ashore on Cat Island, near Bird Point, and to fit out immediately and return. General quarters were sounded and orders were read. Expressions of sadness, disappointment and despair filled the faces of the crew, and when "piped down" many of them seemed so dazed they did not leave their places until again ordered. In fact,

they were about worked to a stand still. Immediately eight of the best men were sent to the Naval Hospital, some with typhoid fever, and many others were sent home as convalescents.

Volunteers from the other ships were called for, and responded so that in about an hour there were 299 men at quarters. Coaling ship proceeded day and night, and on the following morning, November 7, at 9:45 the *Vulcan* was again under way, passing out between Capes Henry and Charles about 12 o'clock, finding in about an hour that same old storm that had already given so much trouble, returning up the coast. The *Vulcan* fought it all the way down, and in three days found the *Teresa*, located as had been described, within a few miles of the spot where Columbus is supposed to have first landed.

With some difficulty a boat was launched, and on rounding the *Teresa's* stern it was found she was resting on coral rock in 20 feet of water at low tide aft, although she drew 30 feet when abandoned. With each sea the sides of the ship creaked and groaned, as they were working badly, so much so that it was deemed unsafe to leave a marine guard on board, although possession had been taken in the name of the United States Government. The Stars and Stripes were made fast to the smokestack, as the military mast had been pounded out, and had gone by the board, lying under the ship. The engines did not



(By courtesy of Leslie's Weekly.)

MARIA TERESA ASHORE ON CAT ISLAND.

move with the ship in its vibrations, as they had gone through its bottom. A 3½-inch cross-tie rod between cylinders had broken, the space between ends being 7½ inches, showing that everything had gone adrift and it was impossible to save the wreck. The *Potomac* was dispatched to Nassau to cable the news and ask for instructions, which were given.

An accident to the *Potomac's* machinery compelled the *Vulcan* to take off two heats in the brass foundry, as castings were required for repairs. It required two days; cargo ports could not be opened, and the ship was rolling badly. Imagine, if possible, an attempt to "pour off" at sea, with two men steadying the one holding the crucible, while others stood ready with shovels and sand to cover the fluid metal should it spill or break away, and a fire brigade ready with hose and buckets if required.

The Secretary of the Navy, in his annual report, including the operations of the war with Spain, states: "The desirability of having a vessel accompanying the fleet thoroughly equipped for making repairs was early apparent. . . . Her usefulness has been universally admitted."

The Engineer-in-Chief of the Navy, Rear Admiral George W. Melville, U. S. N., in his annual report, also including the operations of the war, states: "The *Vulcan* proved of the highest usefulness to the fleet, making repairs of all kinds and furnishing much needed supplies to every department of nearly every vessel. Her unusual facilities and the large number of skilled mechanics on board (about 100) enabled her to make repairs of all kinds, including hull work, gun mounts, dynamos, main steam pipes, main piston rods (for small ships), brass castings without end and iron castings in considerable quantities. This last is especially interesting, as the first instance of the successful use of the cupola on ship board."

Captain F. E. Chadwick, U. S. N., in command of Admiral Sampson's flagship, the *New York*, speaks of the *Vulcan's* work: "Thoroughly efficient and well-looked-after machinery mean facilities for instant repairs. This last element appeared upon the scene somewhat late, but none the less welcome. The *Vulcan* arrived in Guantanamo Bay well equipped both with mechanics and tools, and did most valuable service. . . . She was not large enough. It would have been better to have had a considerably larger ship."

Admiral Cervera, in command of the Spanish fleet, also appreciated the features brought out in the above reports, as is evident from his own communications to the Spanish Government before he was

ordered to leave the Cape Verde Islands for Cuban waters, in that he forcibly brings to the attention of that government his inability to make any repairs to the vessels of his fleet, even should he strike a telling blow upon some American commercial centre.

The writers desire to thank the officers and crew of the *U. S. S. Vulcan* for valuable assistance which they have rendered, and to acknowledge their indebtedness for photographic views, engineering data and other information.

Especial acknowledgment is made to the Engineer-in-Chief of the Navy, Rear-Admiral George W. Melville, U. S. N., for most helpful encouragement and valuable statistics, drawings and information.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

VII.—ELEMENTS OF A MODERN MACHINE SHOP.

MOST machine shops are not made, they grow, and consequently there are few, if any, in which every detail is arranged in accordance with the latest practice,—even in those cases where the proprietors themselves are thoroughly familiar with the latest developments in the art of producing modern machine tools. I know of no machine shop in which the latest equipments are combined with buildings of the best design. Having had the opportunity of being intimately connected with the designing and equipping of large machine tool works, in which it has been the intention to adopt every modern improvement, I have had special occasion to consider this problem, and have followed the development and realization of plans which, for three years have called for unremitting application on the part of those interested, and are not yet consummated. The manufacturer of machine tools is confronted with nearly the same problem which any other manufacturer has to solve when erecting new works. Unlike most articles of manufacture, however, machinery is never produced in what can be called, comparatively speaking, large quantities. It follows then that the organization necessary to meet the requirements for producing in small quantities must be different from that which is possible where operations can be repeated day after day, the year round, on parts remaining unchanged in design while thousands, or perhaps hundreds of thousands, of one particular article are produced. In considering the organization necessary for the production of machine tools, heavy machinery will be left entirely out of the question, and only such machinery will be considered as is made in fairly large quantities, of medium weight, and of standard design. By small machines are meant those which weigh from 500 to 2,000 lbs., in some instances perhaps 3,000 lbs. The first natural division which should occur in organizing a machine shop for the manufacture of machinery of this weight, is, between those departments in which small parts are produced, and those for the heavier work, such as beds, columns, floor plates, etc. For heavier work, most of the operations will, of course, be confined to milling, planing and boring. For the

lighter work all the operations common to machine parts must be performed, such as chucking, turning, grinding, milling, planing, scraping, drilling, tapping and, finally, assembling. As any great amount of repetition work is impossible, it is out of the question for any machine manufacturer to put down a complete plant of machines arranged in departments, each department being confined to the production of a single part. In order, however, that organization may be established, and that a high degree of productivity may be possible, work must be grouped under various operations; thus, different parts which must pass through the same departments, must be operated upon by the same machines,—with a change of fixtures. The essential elements of a modernly organized machine shop may be enumerated in the following manner:

1. Casting Store Room.
2. Planing and Milling Department for light work.
3. " " " " " " heavy "
4. Scraping Department.
5. Chucking Department.
6. Turning Department.
7. Screw Machine Department.
8. Gear and Rack Cutting Department.
9. Grinding Department.
10. Polishing Department.
11. Drilling Department.
12. Assembling Department for Machines.
13. " " " " " Small Parts.
14. Inspecting Department.
15. Store Room for Finished Parts.
16. Store Room for parts in process of manufacture.
17. Drawing Room.
18. Drawing Store Room.
19. Pattern Shop.
20. Pattern Storehouse.
21. Smith Shop.
22. Hardening, Tempering and Annealing Department.
23. Steel Stores.
24. Cutting off and Centering Department.
25. Foundry.
26. Laboratory.

To the above there are many sub-divisions and minor departments, but to deal with them would extend the limits of the present paper too far, therefore only the briefest comment on each heading will be possible. Again, the actual divisions and groupings of departments and the number of foremen to be employed necessarily depend on the size

of the shop. The elements enumerated, however, exist in all machine shops. Comments which follow refer especially to *large* shops, where a limited variety of machinery is made in large quantities; several of these exist in the United States, though the Loewe shops in Berlin are the latest of this type.

Casting Store Room. It is practically impossible always to fix the exact date when castings will be wanted in the shop; even if it were, the foundry cannot always be relied upon to deliver. To avoid delays consequent on non-delivery of castings, and to have material ready at the moment it is wanted, it seems necessary to provide in every machine shop an ample store room for castings of standard parts. Without this department, economic disposition of work and exact control of costs of material is difficult. In all machine shops valuable floor space which ought to be used for manufacturing purposes is occupied simply as storage room. Of course, space can be most economically used in a specially fitted store room, which should be so arranged that stock can be quickly inventoried, and the heavier parts easily transported.

Planing and Milling of light parts may be arranged in one department under one foreman, as surfaces are most easily reduced, in many cases, by a combination of the two operations. Some operations are performed more cheaply on the milling machine, others on the planing machine,—the parts going from one to the other. Of course, in this case it is the foreman's duty to reduce costs by carefully studying the operations and applying them to the machines best adapted for producing the cheapest work. Many parts are handled more cheaply without the use of special fixtures or appliances, while, in other cases, where parts can be more largely duplicated and are of special form, they can be produced more cheaply with the aid of fixtures and jigs, which are made for different parts and are used on the same machine.

In planing and milling heavy work, fixtures are rarely necessary, and the same advantageous methods can be employed by combining the milling and planing machine work in one department. Some parts can be wholly planed, some parts wholly milled, and others partly planed and partly milled. It is well to have this heavy work also under one foreman, whose whole duty is to produce flat finished surfaces cheaply by whatever methods or appliances are best adapted to the end in view.

Scraping Department. This important branch can be made the object of more careful development than is usually practiced in machine-shop work. The production of true scraped surfaces is an art; the

tools to be used are of special form and should be in the hands of skilled workmen, and the appliances for handling and holding parts while being operated upon, are numerous. This department is worthy of more study and special attention from the machine tool manufacturer than it usually receives.

Chucking. Truly flat surfaces and truly cylindrical holes are, of course, the foundation of all good machine work. It is surprising that this chucking, or boring, has received so little attention from European machine-tool makers. Holes of varying dimensions, and out of true, are a fruitful source of bad workmanship and expensive fitting. The practice of maintaining the chucking department is now thoroughly established in American machine shops, even in those with the smallest pretensions. Everything requiring cylindrical holes should be sent to this department, where parts are bored and finished on chucking machines specially adapted to the purpose, and holes are kept to size by limit gauges. In this way accurate work can be done at from one-half to one-third the expense of ordinary methods, as practiced in European shops, by the lathe hands, or turners.

Turning Department. The equipment for this department is comparatively simple, although much greater saving can be effected by more study of detail than is commonly carried out. Automatic lathes can be largely employed, and, when properly arranged with fast feeds and, in some cases, with two or three cutting tools, will effect great saving. Expensive smith work can often be avoided by a comparatively small investment in automatic lathes which take heavy cuts at fast feeds,—one operator being able to attend to two or three lathes. Where a grinding establishment is used in connection with the production of cylindrical parts, fast feeds and rough cuts can be made, thus doing away with a large amount of the so-called skillful turning which is practiced in many cases, by machine-tool makers, and is a waste of effort and files, and which, moreover, produces poor work.

Screw Machine Department, fitted with machines for the production of screws, nuts and bolts. Automatic turret machines have been rapidly adopted within the last few years by leading makers. The scope of the screw machine is fast extending to such an extent that in large works a greater part of the automatic and hand machines is used for producing a great variety of machine parts, besides the ordinary machine-screws, such as pins, studs, washers, oil caps, etc. The most important developments have lately been made in the heavier types of turret machines, which should come in this department, so that they are replacing lathe work, and are turning out parts up to 2 inches dia-

meter and 24 inches long at 50 to 100 per cent. cheaper than the lathe. All this class of work should be specialized in one department under a competent foreman, whose sole occupation should be to perfect and extend the use of the turret machine, which has a great future before it.

Gear and Rack-cutting Department. As cast gears and racks are fast becoming obsolete in the best machine tool practice, this department should receive more and more attention at the hands of machine-tool makers. In the best works it is considered worthy of the supervision of the highest class of foremen and of engineering talent, as gearing is a science in itself and the production of perfect running gears enters largely into the successful working of nearly every machine tool. Accurate and perfect running gears can now be produced by the aid of automatic gear-cutting machines, at a price that is claimed by some makers to compete with that of the ordinary cast gear. The recently developed Warren bevel gear machine makes it now possible to produce accurately cut bevel gears at a very low cost.

Grinding. This important branch has really, within the last few years, had more to do with changing machine-shop methods than almost any other factor. The highly developed and accurate-working cylindrical grinding machine is within reach of every machine tool maker, and the production of accurately finished parts on such machinery has been largely instrumental in reducing the prices and increasing the accuracy of modern machine tools. It is now recognized that no method of finishing cylindrical and, in many cases, flat surfaces is employed which approaches so near perfection as that of grinding. One operator can attend several machines, and produce work which, for accuracy and cheapness, cannot be turned out by the most skilful turner or planer hand. Surface grinding should receive serious consideration from manufacturers, even as a means of merely finishing flat surfaces, without any consideration of accuracy.

Polishing. The special object of a polishing department is to remove from the lathe hand an operation which can be performed by unskilled labor, and on most ordinary machines. At the same time, the removal of emery work from the lathe which is used for accurate turning, is but reasonable and profitable. This polishing department should be separated, in the same way as the grinding department, from the other machine work.

Drilling Department. This department cannot, perhaps, be too sharply separated from the others; nevertheless, it calls for distinctive consideration, and an examination of the latest methods of jig-

ging and boring, even of large parts such as lathe head-stocks and carriages, will show that, as a special department, it is worth more consideration than most machine-tool makers give it. If the shop is properly organized, this work can be profitably separated and put under special supervision, the proper machines made use of for different operations, clumsy methods of boring abolished, work done cheaper, and standard dimensions more easily maintained.

Assembling Department for Machines. The principal requirements are good light, special facilities in the way of cranes and hoists for handling parts, and comparatively little machinery,—the principal item for consideration being cheap transportation. Facilities for readily inspecting, testing, and running machines should also be provided.

Assembling Department for Small Parts. The chief requirements are good light and work benches with a small number of machine tools, principally drilling and tapping, as of course it should be the object throughout the various departments to send parts to the assembler or fitter which require little or no machining.

Inspection. A department which nominally exists in nearly every machine shop, but is, in reality, properly developed in few in either Europe or America. The inspection of a machine tool should begin with its finished parts and should end only when it is ready to ship. Spindles, bearings, planed surfaces and scraped surfaces should be inspected as fast as they are finished; without this the final inspection, when all parts are assembled, is of little value. Unless this detailed inspection is given, no machine can be guaranteed to stand the test of actual service, even if, as an assembled machine, it shows no imperfections. To prescribe the tolerances and limits between that which is ideal and that which experience shows to be practical and commercial, is not easy; it is, however, necessary to work out thoroughly a system of inspection for those who wish to maintain a high standard of excellence.

Store Rooms for Finished Parts. The object of this department is to maintain in order and keep on hand a supply of such finished parts as can be produced in large quantities. They may be single pieces or perhaps sections of machines which are ready to be combined with the heavier parts in the heavy assembling department. Proper organization would, of course, naturally dictate that a system of inspection should be maintained in this department, and that the stores should be under careful management.

Store Room for Parts in Process of Manufacture. This is for

the proper storing and control of such parts as, during the process of manufacture, cannot be finished at once, but have to await their turn before they can be brought to a finished state in the various departments; these must be cared for, must be under control and easily inspected. This room can practically be combined with the Store Room for finished parts.

Drawing Room. Although this is aside from the general manufacturing equipment, the drawing room system is largely responsible for the success which may be attained in the machine shop. A good or bad system of drawing may mean either expensive or cheap work. Proper drawings, which will assist the workmen, must be produced, and the appliances and organization for turning them out must, of course, receive careful attention. It is really the heart of the machine shop, and its influence extends to every department and affects every workman. Anything like a detailed discussion of the best methods cannot be attempted in the present article, and the department can, at the most, be simply enumerated as one of the important factors.

Drawing Store Room. This is a department which seems to be very seldom seriously considered, either in planning new works or in the maintenance of old establishments; it should, however, receive careful attention. It should be central with the entire works, in such order that careful records can be kept of every working drawing,—no matter of what date, and so kept that they can be easily consulted. As these records are valuable, fire proof storehouses are indispensable requisites of a drawing store room.

Pattern Shop. While the equipment of a pattern shop is not at all extensive, the cost of production can be reduced, and accurate and cheap work turned out, with the aid of labour-saving machines and the excellent carpenters' tools that are now obtainable. The best of facilities should be planned in the way of a well lighted and roomy shop, with good fittings.

Pattern Storehouse. The chief requirements of a pattern storehouse are that it should be absolutely fire proof and arranged so that every pattern is available, with the least possible annoyance and delay, and stored in as small a space as is consistent with good order. Systems of recording and numbering patterns are numerous. At the hands of some manufacturers, the pattern storehouse has received great consideration; it should be light and dry, and an even temperature should be maintained.

Smith Shop. The production of a machine-forging is an ex-

pensive operation, as it usually means the work of two or more men and a fire. Consequently, the machine shop should avoid forgings as much as possible, and, in the latest practice, the endeavour is made to do this by using, as far as can be, parts cut from the bar. On account of the expense of machine forging, the equipment of the smith shop becomes, of course, an important item. Smith fires should receive attention in the way of special design, the latest appliances for taking away smoke, and for furnishing blast. Where parts can be made in quantities and it is necessary to forge, the trip-hammer and drop-hammer or steam-hammer can be used.

Hardening, Tempering and Annealing Department. Appliances for this department are various, and almost every manufacturer has developed his own special methods of case-hardening, tempering and annealing. The requirements of a modern establishment should embrace the best and most economical furnaces, labour-saving appliances for handling material, and special facilities for tempering small tools. By the careful manipulation and control of this department immense savings can be effected in any machine shop.

Steel Stores. This should embrace specially designed fixtures for holding material and the appliances best adapted for handling parts with as little hand labour as possible. Many manufacturers favour the system of standing the bars of material on end where vertical space is available.

Cutting-Off and Centering Department. This should be in close proximity to, or perhaps form a part of, the steel storehouse. Such appliances should exist as would allow the cheapest transportation from the racks, which hold the material, to the cutting-off machines. Centering machines are naturally worked in connection with the cutting-off, so that parts ordered from the machine shop are supplied cut accurately to length and centered, in most cases, ready for turning.

In connection with the last-mentioned items three—viz. smith shop, hardening, tempering and annealing department, and the steel stores—it seems but natural that they and the cutting-off and centering department should group together in a well organized factory, as the steel storehouse must furnish material not only to the cutting-off machines but also to the smith shop, and many of the parts which are cut off or forged have to be annealed before they are taken to the machine-shop.

THE ENGINEERING DEVELOPMENT OF PORTO RICO.

By Herbert M. Wilson.

DISCOVERED 400 years ago by Columbus, Porto Rico, after three centuries of the mediæval misrule of Spain, has not yet awakened from its slumbering soil the full measure of the harvest which awaits the garnering of modern industry. Had a fraction of the money and energy devoted to extracting from its people the last centavo of tribute been expended in developing its agricultural possibilities, Porto Rico would be to-day the garden spot of the West Indies.

One has but to turn to its sister island, Jamaica, which has flourished for a less period under Great Britain's beneficent rule to realize what the future holds in store for her. While Jamaica is traversed in all directions by magnificent highways over which produce is cheaply transported to market, Porto Rico boasts but one military road. While Jamaican coffee, oranges, and bananas are world-famed for their quality and are prodigal in yield, Porto Rico produces the same in insignificant amount and of unheralded, though excellent flavor. Yet no one who has seen the two islands and who realizes the richness of the soil, the mildness of the temperature and the humidity of the climate of Porto Rico, can doubt for an instant which would be the more productive under an equally liberal and intelligent government.

The sanitation of the cities of Porto Rico and their water supply must be improved to make them habitable by Caucasians. Modern systems of inland transportation by railways or highways must be provided, that every portion of the island may be easily accessible to the investor and home-seeker, and that the teeming products of its soil may be cheaply conveyed to the seaboard.

The climate of Porto Rico is naturally salubrious, and owing to its steeply rolling and well drained surface nothing but man's own indolence and filthiness prevents its being one of the healthiest of tropic countries. So bountifully has nature lavished her best gifts on this, the latest addition to territory under Anglo Saxon rule, and so little have its Spanish rulers done to develop and utilize these, that of her it may be truly said, "every prospect pleases and only man is vile!"

It is my purpose in this paper to show the resources of the island in water supply, something of its climate and topography, and to point out how these may be utilized to its improved sanitation and its transportation facilities.

Situated between latitudes $17^{\circ} 54'$ and $18^{\circ} 30' N.$, and longitudes $65^{\circ} 13'$ and $67^{\circ} 15' W.$, the island of Porto Rico is well within the torrid zone. It is in the same latitude as the city of Mexico, the Hawaiian Islands, the centre of the Sahara Desert and of Bombay, India. Because, however, of its situation as the easternmost of the Greater Antilles, its climate is so tempered by the trade winds as to render it



TRADE-WIND BLOWN TREES, SAN JUAN.

more moist and more salubrious than that of any of the places named, with the possible exception only of the Hawaiian Islands.

The trade winds here blow with unceasing regularity throughout the year, yet not with such force as to be disagreeable. The precipitation on the island is as varied in amount and character as that of the entire United States, a fact due to these trade winds and to the topography of the island. Heavily moisture-laden from the warm ocean, the winds impinge against the mountains where the contained moisture is quickly condensed and squeezed out of them as from a sponge, falling in heavy showers of sudden occurrence but short duration. Passing southward and westward the same winds continue to precipi-



MORNING MIST OVER TOBACCO FIELD, CAGUAS.

tate even more abundantly at the summits of the mountains near the centre of the island, and passing these they suddenly are freed and expanded, and being thus given the power to carry a larger amount of moisture, little rain falls from them over the southern and western slopes.

These conditions are clearly recorded in such meteorologic data as have been collected by the United States Weather Bureau from the archives left by the Spanish government. At Hacienda Perla, the average annual precipitation is 123 inches, yet at San Juan, but 15 miles farther west, the average annual precipitation is only 54 inches.

Apparently great as are these extremes of precipitation, they are as nothing compared to those between points on the south coast and those on the north. According to such data gleaned from Spanish records, as are now available, it appears that the average annual precipitation on the southern slopes of Porto Rico is but 20 inches, as against 50 to 123 inches on the northern slopes. Moreover, this is distributed quite irregularly, there being an authentic record of nearly three years without an inch of rainfall at Cabo Rojo near the extreme southwestern end of the island; while at Guayama, immediately south of San Juan, there is one record in 1893 of 13 months without a drop of rain.

The above facts are important in connection with any discussion of the water resources of Porto Rico, or of highway transportation or of city sanitation, and they show clearly that any generalizations on these subjects are necessarily valueless, and that small as is the island, each particular locality of very limited extent must be considered as a problem by itself, in connection with any public work or private engineering undertakings.

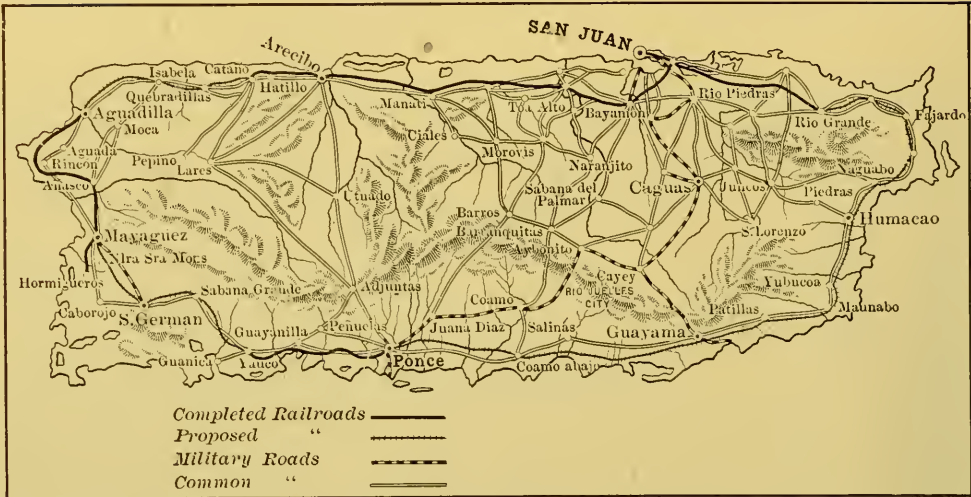
The topography of the island of Porto Rico exerts fully as much influence on problems for the future development of the island as does its precipitation. It is exceedingly mountainous and highly eroded, though none of its summits attain great altitudes. It is noted for the abruptness with which the foothills of the mountain slopes plunge into the ocean and the absence of any true coastal or marginal plain. A



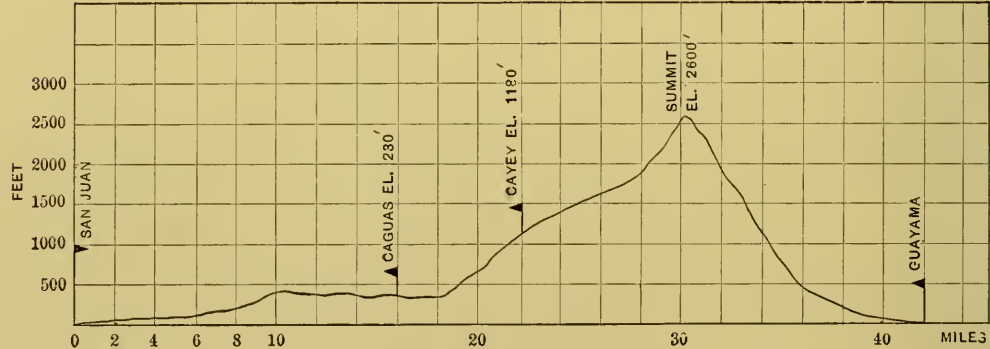
TOPOGRAPHICAL MODEL OF PORTO RICO.

series of connected mountain ranges extends irregularly through the length of the island from its northeastern point to the eastward of San Juan, to its extreme western point near Cabo Rojo. These form a main divide between the drainage of the northern and southern coasts. The most commanding of these mountain ranges is the Sierra de Luquillo, lying between San Juan and Fajardo, the highest summit upon which, El Yunque, has an elevation of approximately 3,750 feet and is the highest point upon the island.

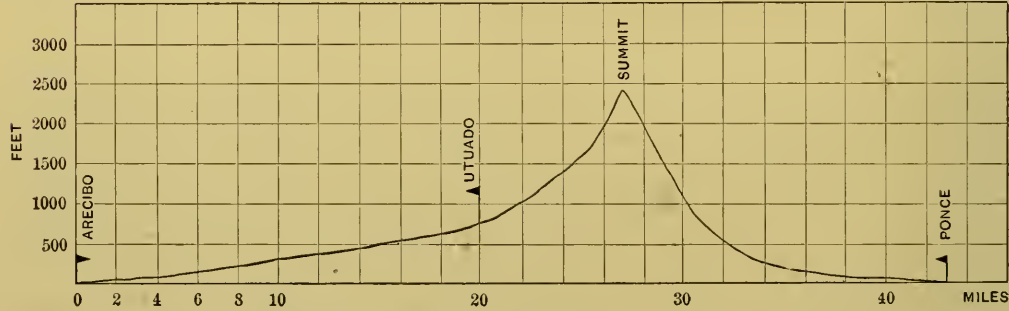
To the south the main spur of the Luquillo connects this mountain range with that of Sierra de Cayey, the highest summits of which attain but a little over 3,000 feet in altitude. These mountain ranges skirt closely the eastern and southern coasts, so that the greater portion of the drainage of the eastern third of the island is to the north, the eastern and southern coasts receiving the drainage from a narrow



MAP OF THE ISLAND OF PORTO RICO.



CROSS SECTION PROFILE, SAN JUAN TO GUYAMA.



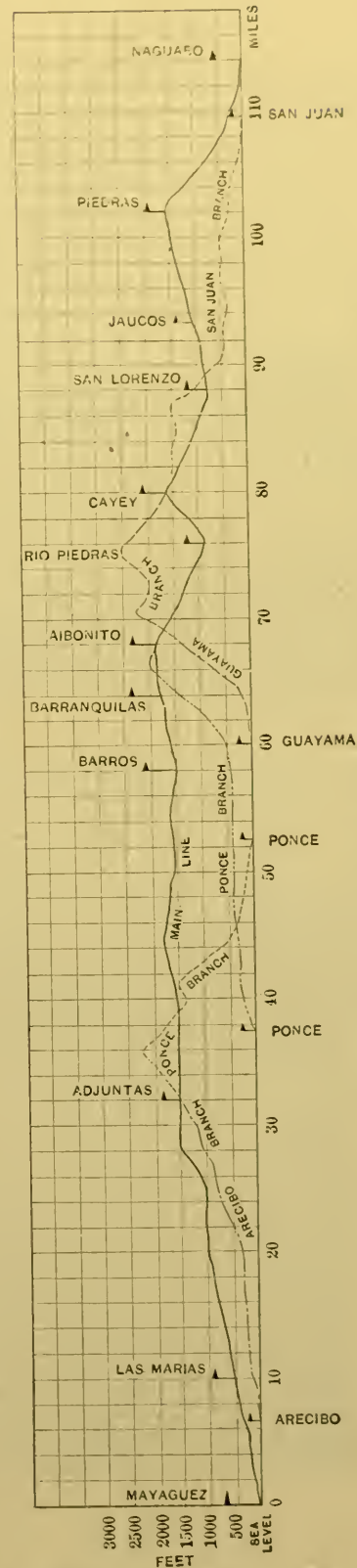
CROSS SECTION PROFILE, ARECIBO TO PONCE.

belt of country but 5 to 10 miles in width. West of Aibonito the Sierra de Cayey merges into the Cordillera Central, a great mountain mass, which extends thence with altitudes of 3,000 to 3,200 feet to its culminating point, El Guilarte, the second highest peak on the island, 3,610 feet above the sea. West of this point several well defined mountain spurs reach the sea coast to the north and south of Mayaguez.

This controlling east and west system of mountains is the barrier against which the trade winds beat, and its crests mark clearly the dividing line between the humid regions of the northern and the semi-humid regions of the southern coasts. It is also the main divide which separates the waters flowing toward the northern ocean from those flowing to the southern sea, and as its average position is about one-third nearer to the southern than the northern coast the drainage area to the north is about twice as great as that to the south.

It is evident that the mountain slopes are steep, the fall of the rivers great and the velocity of the water high. It is also evident that those streams which flow to the north are three times as long as those flowing to the south, the former having an average course of 25 to 35 miles, that of the latter averaging but 5 to 10 miles. Those to the north, therefore, draining the greater areas, are necessarily greatest in size and volume, and are less abrupt in slope than those draining to the south, which plunge from 3,000 feet to sea level within comparatively few miles.

Porto Rico is unusually well watered because of the comparative humidity of the climate. Flowing into the northern ocean are twelve streams of considerable size; toward the west coast are four of relatively equal size; toward the south are seventeen of lesser magnitude; while to the east are six of still less magnitude. Each of the larger rivers has its sources high among the summits of the Central Cordillera. Those flowing to the north and west are characterized alike by



LONGITUDINAL PROFILE OF PORTO RICO, WITH BRANCH PROFILES TO PRINCIPAL SEAPORTS.



FORDING RIO LOIZA NEAR CAROLINAS.



FORDING RIO CANOVANOS, LUQUILLO MOUNTAINS.

precipitous descents of from 1,000 to 2,000 feet in the first five miles of their course; thereafter they flow more leisurely and with necessarily increased dimensions to within about five miles of the coast, where they emerge at sea level in the alluvial playas or river bottoms about their mouths. On the southern and eastern slopes the rivers fall away more abruptly as mountain torrents, from the highest summits to within 100 feet of sea level in the first five miles.

On the northern coast several of the larger rivers have, at low water stage, bed-widths of from 150 to 200 feet, average depths of 2 to 3 feet and minimum discharges of 150 to 1,000 second-feet. On the southern coast the width of the stream beds is in a number of cases



DRY BED OF RIO PORTUGUES, NEAR PONCE.

as great as those on the northern coast, but owing to the irregularity and small amount of precipitation the average amount of discharge is but 50 to 75 second-feet. Again, the northern rivers, more like those of other humid regions are less subject to sudden flood rises of great amount. The southern streams, like those of our western plains, are subject to sudden freshets of great volume, subsiding rapidly to their customary small discharge.

The largest river on the island, the Rio Loiza, which enters the north coast about 15 miles east of San Juan, has at Carolinas, the point at which it leaves the mountains, a surface width of about 220 feet, with an average depth of 3 feet, and a velocity of approximately



DRY RIVER BED AND IRRIGATING CONDUIT.

2½ feet per second, making its minimum discharge about 1,600 second-feet. In flood the same river discharges probably as much as 15,000 to 20,000 second-feet. Twenty-five miles from the coast at Caguas, and above its main branches, Rios Gurabo and Loiza, one of its branches, Rio Turabo, has a surface width of 100 feet and an average depth of 1½ feet, and a velocity of about 3 feet per second, making its discharge nearly 450 second-feet.

As an example of the dimensions of the south coast streams, the Rio Coamo at the city of the same name and at a distance of about ten miles from the coast and an altitude of 350 feet, has a surface width of about 100 feet, the river bed being about 250 feet in width. Its average depth is nearly 2 feet and its minimum discharge about 100 second-feet, its maximum flood discharge perhaps reaching as great a volume as 5,000 to 8,000 second-feet.

The island of Porto Rico is a virgin field for the exploitation of the promotor through the resourceful skill of the engineer. As yet, practically no engineering work worthy of that name has been done, other than the little governmental improvement of the harbor of San Juan and of the one military road which crosses the island. The opportunities for development of water power which may be utilized by electric transmission, either in running sugar mills or other machinery, or electric railways, or in electric lighting, are abundant and well distributed. Where rivers of considerable volume fall 500 to 1,500 feet



BRIDGE OVER SEMI-DRY RIO COAMO.



BRIDGE NEAR CAGUAS.



REPAIRING MILITARY ROAD NEAR CAGUAS



A GOOD (?) MOUNTAIN ROAD.

in a few miles, the power which is available is evident. Moreover, there is such a vast field for public improvement in transportation facilities and in the use of machinery that one has no difficulty in drawing in the imagination a vivid picture of what this water power must mean for the future of Porto Rico.

Aside from such public works as were a necessity of the military control of the island or such as aided direct'y to the comfort of the Spanish officials, the degree of progress heretofore made in the introduction of civilizing attributes is only such as was attained in the United States two centuries ago. The people live chiefly by agricul-



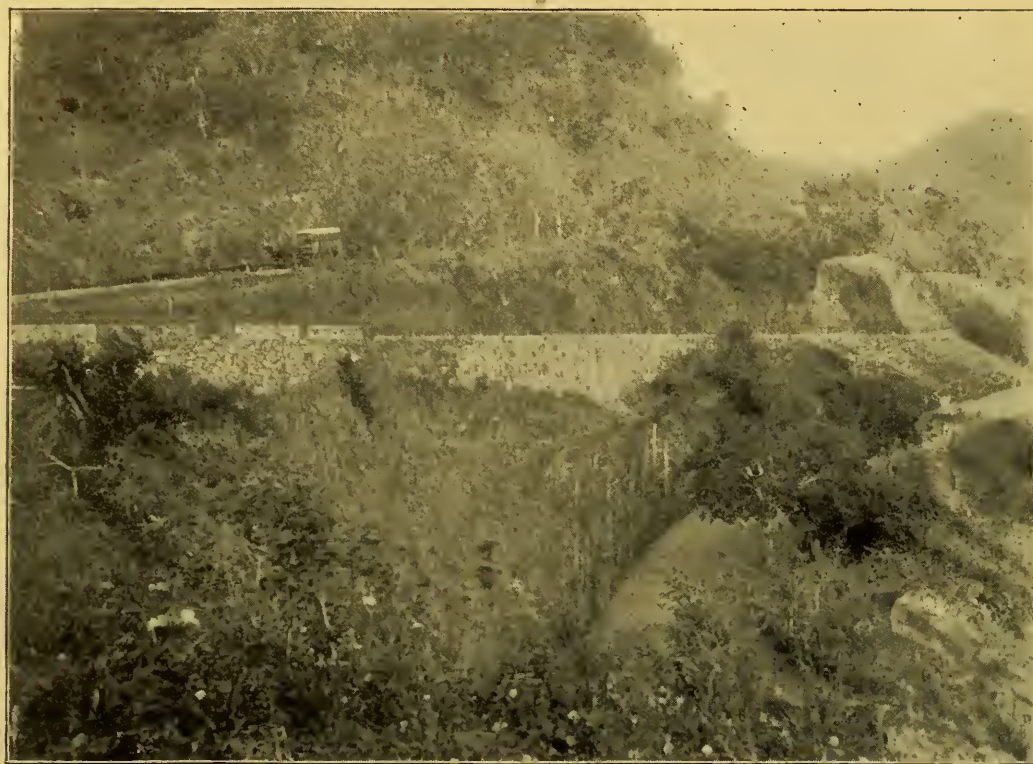
BETWEEN CAYEY AND AIBONITO.



IN THE LUQUILLO MOUNTAINS.

tural pursuits. These are carried on by methods and tools such as were used by the early colonists of America. The means of insular communication by roads and trails are no better than those found in the back woods. The legal conduct of the provincial governments and cities, and the water supply and sanitation of the latter are equally primitive. This in spite of the fact that the island has been completely deforested, that almost every square foot of the land is or has been under cultivation, and that every portion of the country is well inhabited.

The population of Porto Rico consists of 1,000,000 people, of whom only 325,000 are negroes. The largest city on the island, San Juan,



ROAD DESCENDING AIBONITO GRADE.

has but 30,000 inhabitants; the second, Ponce, 22,000; the third, Mayaguez, 12,000, after which there are a dozen smaller villages, having 10,000 inhabitants and less, scattered generally throughout the interior. The density of the population averages 225 per square mile. These figures and the smallness of the cities indicate how generally the inhabitants are distributed throughout the island. That there is certain to be in the immediate future an astonishing rejuvenation of this land accompanied by the construction of many important engineering undertakings is evident from the bare recital of the above. How extensive are the resources and what is the full measure of its possible future development might be further emphasized by a statement of its present relatively insignificant trade.

Nothing of importance can be expected from the development of the mineral resources. These are insignificant in amount and variety, as shown in an extract from the Twentieth Annual Report of the United States Geological Survey, by Mr. Robert T. Hill, my companion in studying the island. The most generally distributed structural material is clay. From this, bricks, tiling, and to a lesser extent pottery, are already made. But a small proportion of these, however, which is required for local uses is manufactured in the island,

the larger amount, especially of tiling and pottery, being imported. Materials for building masonry structures are abundant and well distributed. Good clean, sharp sand is found in nearly all the rivers. Chalk, clay, and silica for the making of artificial cements abound in the costal formations. Both white limestone in the costal formation, and blue and gray crystalline limestones in the mountain regions, abound, and these are well adapted to the making of lime. Many of the impure limestones appear to be well adapted to the making of natural cement, but, as fuel is scarce and expensive, it is doubtful if these can be profitably utilized. Building stone of all kinds is abundant, including the hard blue and gray massive limestones found everywhere in the mountains, also volcanic boulders, and lumps of porous white limestone, which are popularly used by the native masons. Near Juana Diaz is a belt of beautiful marble of great hardness and variegated color, which is extensively used for bridge piers and other structural purposes. A fine flagstone used in San Juan for sidewalks is abundant and is quarried chiefly between Cayey and Aibonito.

Excellent material for road metalling is furnished by all of the above, and also is found everywhere in the volcanic tuffs, of which the larger portion of the central mountain mass is composed. Moreover, good riprap material for dams and small stone for road metal is found conveniently for local use, in many places, especially on the north side of the island. This occurs as a hard white coral limestone which is



MUDDY ROAD NEAR AIBONITO.



IRRIGATION DITCH NEAR PONCE.



IRRIGATED SUGAR CANE NEAR PONCE.

crystalline and breaks into firm, sharp angular pieces. Gypsum is found abundantly along the southern slopes of the mountains, especially to the north of Juana Diaz and near Ponce. This material is extensively used for plaster, both for house interiors and their stuccoed exteriors.

The industrial development of the island, will, as shown, be on the lines of increased agricultural output. Already much has been done in the way of encouraging the coffee product, as this was one of the articles chiefly desired for export to Spain. The production of sugar also has been well encouraged in the past, and the development in its production must in the future be largely in the direction of improved mechanical separation and crystallization, rather than in its cultivation. Great agricultural development may, however, be expected in the production of a better grade of bananas, and these in greatly increased quantities; also in the cultivation of oranges, lemons and similar fruits. All grow abundantly, but practically in a wild state at present. No attempt has been made to introduce those varieties best suited for exportation, as has been done, under the encouragement of American shippers, in the islands of Jamaica and Antigua, and on the Central American coast.

The engineering development of the island must, as has been indicated, be primarily in the utilization of the unparalleled water power which is everywhere available for conversion into electric energy and will require transmission to but comparatively short distances. Through this and the great abundance of road metal, building stones, lime and clay; the construction of electric tramways, of highways and of bridges will be greatly facilitated and enormously increased in amount in the near future.

The business opportunities awaiting development are therefore of two kinds: Those which will attract the exporter of fruits and other tropical vegetable products, and those which will attract the builder of railways. In the latter direction many excellent opportunities must be found for the building up of cities or even of seaports and boom towns, and money making projects will undoubtedly soon be exploited in large numbers. Nothing of this sort can as yet, however, be successfully undertaken until such laws have been made and such government provided by the United States Congress as will secure land titles, give a stable monetary system and, especially, will relieve the exporter and importer of onerous duties and taxation. Already several important engineering projects have been examined by American capitalists. Because of the lack of good harbors, a project is now

on foot for the improvement of the most promising natural harbor, Jobos, just south of San Juan, and a boom town site is already being surveyed in the expectation of making this the commercial port of the island. Another project is the tunnelling of the narrowest portion of the central mountain range near Cayey, with a view to diverting the abundant waters of the Rio Plata to the south slopes back of Guayama and Jobos, the diverted streams there to be used in generating electric power and in irrigating the semi-arid but fertile lands. One syndicate is already in the field, and their engineer and lawyer have acquired several water rights of 500 horse power and two of 1,000 horse power on the head waters of the Rios Plata, Manati and Arecibo. Thus, while the field for the development of the engineering resources of the island is large, it has already been cursorily investigated.

The engineering possibilities of Porto Rico may be divided into the following distinct classes: First, those which are of a public nature; as the improvement of harbors, of the water supply sanitation of cities, and of the construction of highways, the latter presumably by local rather than central government; and, second, those which will be undertaken by private resources; as the building of railways and the development of water powers.

In regard to public works, harbors come first in importance. The most improved harbor and the only safe one is that of San Juan. This is land locked and is safe for vessels drawing less than 25 feet of water. The bar, however, is treacherous and the channel across this and entering the inner bay is difficult to navigate. It is now said to be 30 feet in depth, but it is so tortuous that the old transatlantic liner "Berlin," drawing 27 feet, has touched in crossing the bar, and is very difficult to bring in. The area of deep water in the inner bay is moreover comparatively restricted. This is the only harbor on the island in which the depth is sufficiently great, close inshore, to permit vessels to tie up to or unload at wharves or moles. The harbors of Ponce and Mayaguez are little more than open roadsteads. Ocean-going vessels are compelled to anchor at least half a mile or a mile away from the shore and must be unloaded by lighters. Neither harbor is safe in very stormy weather. Three excellent natural harbors are those of Puerto Real de Cabo Rojo, at the southwestern extremity of the island, Guanica, which is west of Ponce, and Jobos which is east of Ponce. All of these are land locked and perfectly safe harbors of refuge. Detailed surveys will develop which is the best,—at present Jobos is preferred. Unlike the conservative Span-

iard, the American will undoubtedly create new cities at whichever of these harbors may prove to have the safest entrance, the largest area of deep water, and especially the advantageous transshipment of freight directly from wharves instead of through the agency of lighters. In this connection there is a field for private enterprise outside of governmental harbor improvement, and an opportunity for creating commercial centers and inland transportation routes, as has been done at Aransas Pass in Texas, at Newport News, Virginia, and at other places in the United States.

Highway construction must be pushed immediately and rapidly, if any development is to take place in the agricultural industries. Roads will doubtless be built, to some extent, as public works, but under the circumstances much construction of this sort may be expected by Americans who becoming possessors of coffee and other plantation lands, and by those who, constructing railways, need the highways as feeders.

The greatest development in private engineering enterprise is necessarily to be looked for in the building of railways. These will undoubtedly be operated by electricity generated by water power. The writer fully agrees with the conclusions indicated by Mr. Lluveras in his article in the February number of *THE ENGINEERING MAGAZINE*. The need of these railways is crying. The conditions are favorable, and the promise of return is rich. Construction of electric tramways will be relatively little more expensive than that of such properly macadamized highways as must be built to withstand the eroding action of the heavy rains. The maintenance of these will be perhaps even less expensive than that of a properly surfaced wagon road. A central arterial system extending approximately from the eastern to the western extremity of the island on the higher slopes of the hills, but not at greater elevation than the various passes, is feasible. Such a system should have feeders or branch lines extending both to the interior towns on either side and to the shipping ports on the coast. Such a line will encounter no serious obstacles in construction. The hauling from the coffee plantations will be chiefly down hill from the higher summits to this line, which will approximate an elevation between five hundred and fifteen hundred feet, and the bulk of the heavy traffic will be over this line, also down-grade to the coast. At various points on the route of such a railway are unsurpassed water powers which will furnish not only electric energy for running the tramways but also motive power for the handling and cleaning of coffee and for the grinding of sugar cane.

As has already been shown, the south side of the island is comparatively arid. Great areas are either not under cultivation, or such agricultural products as are grown produce but relatively small crops as compared with the capacity of the fertile land. On this side of the island irrigation is casually practiced by the larger sugar planters. There are several important irrigation ditches between Salinas, Ponce and Yauco, from which water is now derived. Large amounts of land may, however, in the future be brought under intense cultivation by utilization to the full of the water resources in irrigating the fertile south coast lands.

Among the more important public works which must be immediately undertaken and which may yet in part furnish a field for private enterprise, is the providing of proper water supplies for the various cities. At present all of the cities of the island receive their water supply either from rain caught in cisterns or from gravity supplies of small amount and piped to only a few of the more important streets and buildings. The latter is the case in Ponce and in Mayaguez, while there is being completed for San Juan a fairly satisfactory gravity supply which is pumped from reservoirs a few miles outside of the city. Streams discharging sufficient volumes of potable water are found within easy access of all of the more prominent cities, and there appear to be no engineering difficulties connected with intercepting such waters and conducting them to the towns and with distributing the same in accordance with modern methods. Rarely, if in any case, will pumping be necessary, gravity being probably in every instance capable of giving all the pressure desired.

The sanitary condition of the cities of Porto Rico is at present far below the standard accepted by Europeans, and much must be done to improve it in order to make the island safely habitable by our people. Under the present American régime much has already been done to better the conditions. The more important streets in all the cities have always been fairly well paved under Spanish rule. Their surface slopes are good, and the gutters well constructed. In all of these cities surface drainage of rainfall is employed exclusively, no underground sewer systems being in existence. The more liquid portion of house sewage is also discharged into the streets, and flows through them in the open gutters, generally evaporating before it has gone very far. Fortunately on the rainy side of the island the streets are so often flushed by nature as to keep them fairly clean. The danger points are in the suburbs, where the street washings collect, and especially in the interior courtyards of the buildings, into which house

drainage is discharged and collected in cesspools. These cesspools are invariably foul and are the breeding places of all tropic diseases. They must be abolished, and house sewage and drainage be carried off in underground sewers to be chemically treated or otherwise disinfected before being discharged.

The climate of Porto Rico is comparatively healthy and with proper sanitary precautions should furnish as satisfactory a living place for Europeans as almost any other warm country. The slopes of the land are steep and the soil porous, and on the dry side of the island especially it should be possible for Europeans to live in perfect safety.

The æsthetic side of the island must not be overlooked. Its development will undoubtedly have great influence upon its future. With proper sanitation in the cities, Porto Rico should be an ideal winter resort, for it is naturally one of the healthiest of tropical countries. The mountainous interior is exceedingly picturesque, and will, with proper encouragement, soon attract a large population from the United States. This will consist chiefly of people of large means who will go there to invest in coffee and fruit properties in the mountains and to live on their plantations in the winter. This is the season, moreover, when their presence is most necessary, as coffee is picked, fruits are gathered, and sugar is ground between the months of November and March. Thus absence of proprietors during the summer will entail little risk of loss. Such people will have their horses and carriages, and will enjoy driving in the cool evenings to view the magnificent scenery. Thus their presence will encourage the construction of good highways and the building of electric tramways.

THE EFFICIENCIES OF STEAM BOILERS AND FURNACES.

By R. S. Hale.

THE chief difficulty in discussions of boiler efficiency and boiler economy has hitherto been, if one may say so, that they have been too practical. The subject depends on so many factors that experiments which determine only the practical efficiency give no light on the factors that govern this efficiency, or on how this efficiency may be improved, and as Prof. W. C. Unwin once said in effect before the Institution of Mechanical Engineers, what is needed is, not more boiler tests but a little more practical theory. When it is remembered that the combustion, the air supply, the area of heating surface, its condition as to cleanliness, its arrangement, and the external radiation, all affect the efficiency of the boiler, it is seen that the problem is not a simple one, and in the following paper an attempt will be made to state the relation of the different factors that go to make up the efficiency of a boiler as a whole.

The object of the boiler is to transfer the latent heat, or chemical heat existing in the coal into the heat of the steam. Beginning with the coal, we find that it is composed chiefly of carbon and hydrogen, and a few other elements which are comparatively unimportant. The carbon and hydrogen when burned with the oxygen of the air develop heat, and the amount of heat depends on the product formed. If the coal is burned completely, it develops as much heat as is possible, but, in practice, certain portions of the coal either do not burn at all, or burn to compounds which are still combustible, and therefore have not given up all the heat that they possibly can. The result is, that of the total heat originally latent in the coal a certain portion becomes sensible heat, while a certain other portion does not burn, and remains in the form of latent or chemical heat in the ashes, or in the products of combustion. The loss by this latent or chemical heat which never develops into sensible heat is known as the loss by incomplete combustion, and is the first, though not the most important factor on which the efficiency of the boiler as a whole depends.

After as much as possible of the latent or chemical heat has been changed into sensible heat, the next step is to transfer as much of this sensible heat as possible through the wall of the boiler into the steam,

and it is obvious that the amount of heat thus transmitted depends on the rate at which it flows through the walls at different points as the gases pass to the chimney, and also on the length of time the gases remain in contact with the different portions of the walls. The rate at which the heat flows at any given moment depends on the temperature of the gas at that moment, but after the first moment the gases begin to cool so that the rate of transmission is not constant. The initial temperature, however, and initial rate of transmission depend on the amount of air that has been used to develop the heat, for instance, if one pound of air has been used to develop 1,000 thermal units the temperature should be greater than if two pounds of air had been used to give the same result. The initial temperature of the gases depends therefore, on the amount of air used, but the moment the gases transmit any heat through the heating surface their temperature falls, so that if the initial temperature was, say, 2,000 degrees, then as soon as they have remained in contact with the heating surface for a given interval the temperature would fall say 500 degrees to 1,500 degrees. This fall of temperature will diminish the rate at which the heat flows through the heating surface, so that during the next interval of time, and while the gases are in contact with the next portion of the heating surface, the temperature will not fall as much as before, but will fall to perhaps twelve hundred (1,200) degrees only, and the lower the temperature falls the slower will be the rate of transmission of heat. In addition to diminishing the initial temperature, an increase in the amount of air used diminishes the time that the gases remain in contact with the heating surface. For instance, if twice as much air is used, each pound of air remains in contact with the heating surface only half as long. Another factor that governs the rate of flow of heat from the gases into the steam is the condition of the heating surface, and if the heating surface is covered by soot or scale, the rate of flow will be less than if it is clean.

It should be noted however, that inefficient heating surface, or excess of air does not have the same effect in every case; thus, if we have a heavy scale over all the heating surface, the transmission of heat through the part of the surface where the gas first strikes will be very much diminished, and in consequence the temperature of the gas will not fall as much as if the heating surface had been clean, and when the gas strikes the next portion of the heating surface, the higher temperature of the gas will largely make up for the higher resistance of that part of the heating surface to the transmission of heat. The same general principle applies when we consider the effect of a change

in the quantity of air. If there is an excess of air, which diminishes the initial temperature and in consequence the initial rate of transmission of heat, then the temperature will not fall so fast, and since excess of air not only makes the initial temperature low, and the transmission of heat slow, but also gives the gases less time in contact with the heating surface, it may happen in certain cases that after excess of air has caused the initial temperature to be low so much less heat is transferred to the steam that the gases when they finally leave the boiler may be even hotter than would have been the case if the air supply had been less, and initial temperature had been higher. This is a rather curious result, but has been shown experimentally as well as theoretically.

It is obvious that the ill effects of excess of air, or inefficiency of heating surface will come into play much less when the heating surface is ample than when it is small, since, if, for example, ten or fifteen times the heating surface per pound of steam would be provided, the diminished transfer of heat through the portion of the heating surface that is first in contact with the gases will be balanced by the increased transfer as the later portion of the heating surface due to the higher temperature at those parts, whereas, with a very small amount of heating surface the diminished transfer at first would not be balanced and would necessarily result in a loss. In a similar way it may be shown by theory and by experiment that if the air supply per pound of coal be very small and the heating surface be very efficient, then so much heat is taken out by the first portion of the heating surface that the total amount of heating surface is a matter of comparatively small importance.

This explains the widely divergent results sometimes obtained by boiler tests to determine the efficiency at different rates of evaporation. A series of tests is run at different rates of evaporation and if the air supply per pound of coal is small, forcing the boiler makes but little difference, or indeed if the firemen should happen to use less air per pound of fuel when the boiler is forced, the result on the forced test may even show better efficiency. On another series of tests, however, the air supply per pound of coal may be greater, and then the amount of heating surface become very important, and forcing the boiler will reduce the efficiency to a low figure.

Continuing with the history of the heat, we find that after the heat has been transferred through the heating surface into the steam, the only further loss is the loss from radiation. This has often been reported as being 5 per cent. to 15 per cent. or even more of the heat.

but as will be shown below, this has been on account of erroneous deductions from the test, and as a matter of fact the loss by radiation is probably not over 1 per cent. in well covered boilers. The heat put into the steam less the heat lost by radiation from the boiler itself gives the measure of the performance of the boiler. Any further loss is chargeable against the steam pipe, or engine, and not against the boiler.

So far I have given only a history of the heat from the time it is in the coal until it can be utilized in the steam, but the methods of tests by which these factors are measured is fully as important as their history. If we begin with the loss by incomplete combustion, the most obvious way is, first to analyze the coal and test it in a calorimeter, then to analyze the flue gases, and from these data to determine what portion of the gases is still capable of giving up heat, and how much. The difficulty of this method is purely experimental. The combustible portion of the flue gases consists of hydrocarbon compounds, and of CO (carbon monoxide). The CO can be determined fairly well, but the hydrocarbons exist in very small quantities and in many different forms and one-tenth of one per cent. of many of these forms is a serious matter, for it corresponds to three or four per cent. or even more of the heat of the coal. There is no practical method of flue gas analysis that will determine the amounts with this degree of accuracy, so that the only way to determine the loss by incomplete combustion is to determine the amount of heat originally in the coal, to subtract from this all the other heat developed, and then to charge the difference to incomplete combustion.

An analysis of 103 tests on different types of boilers indicated that the loss from incomplete combustion to hydrocarbons varied from one per cent. to twenty per cent. and probably averages about seven per cent. while the loss from incomplete combustion to CO varies from nothing to twenty per cent. and probably averages about one-half per cent. or one per cent.

The loss of sensible heat in the flue gases can be determined reasonably well from the gas analysis and the temperature of the gases, since the gas analysis and the coal analysis enable us to compute the amount of gas per pound of coal; and from this figure, from the temperature and from the specific heat the total heat units carried away in the gases can be computed.

Of course if there is leakage into the flue after the gases have left the boiler the effect is to reduce the temperature of the gases and to increase their amount without changing the amount of heat in them.

so that the measurement of the actual loss of the sensible heat in the flue gases is not affected, nor is the efficiency of the boiler affected by such leakage. On the other hand, leakage through the setting before the gases have left the boiler reduces their temperature, and in consequence the amount of heat that they can transmit to the walls at the latter portion of the heating surface, and therefore reduces the efficiency. In both cases however, the measurements of the gases and their temperature shows the loss in the flue for that particular test. It may be however, that no inference can be drawn as to other tests with different amounts of air leakage, since if there has been leakage at any point, the gas analysis does not show the amount of gas that has been in contact with the heating surface, so that in case of air leakage the application of the theory of the flow of heat may give erroneous results. Analysis of tests shows that the loss of sensible heat in the flue gases varies from ten per cent. to thirty-five per cent., and averages about twenty per cent.

The loss by radiation cannot be determined from the boiler test itself, and must be determined by a separate experiment which is possible only in certain types of boilers, and even then is a matter of some difficulty. In general it is not determined separately, but the balance left after subtracting the heat in the steam and the heat in the gases from the heat originally in the coal includes both the loss by radiation and the loss by incomplete combustion. In such case the boiler test itself gives no indication of how much heat should be ascribed to each of these two losses, but a comparison of a great number of tests has shown that in the great majority of instances the radiation loss is but small, and that most of the unaccounted for heat has been lost in the form of incomplete combustion.

From the results of the same tests above referred to, it has been shown that the radiation loss from well covered boilers probably averages one per cent.

All the heat not lost in the form of incomplete combustion, as sensible heat in the gases, or as radiation, is available as heat in the steam, and the tests showed that the percentage of heat thus available varies from 50 per cent. to 87 per cent., averaging about 71 per cent. We may therefore state an average heat balance according to the accompanying table.

This analysis indicates the method that should be used in judging the results of tests of boilers or their appliances. For instance, if the radiation loss on a boiler is one per cent., a device applied to diminish the radiation can only save one per cent. If the loss by

incomplete combustion is only seven per cent., a device to give complete combustion can only save seven per cent. at the best. In comparing two tests it is necessary to know not only that the boiler and the furnace are the same, but it is necessary also to know what the different factors were that made up the results in each case. For instance, a complete combustion device is applied and tests show that the efficiency of the boiler which was formerly 70 per cent. is now 77 per cent. Nevertheless, it is entirely probable that the saving was not due to the

Lost in incomplete combustion to hydrocarbons. . . .	7
Lost in incomplete combustion to carbon monoxide	1
Lost in sensible heat in flue gases.	20
Lost in radiation.	1
Available in steam.	71

100 per cent.

The best performance on record is a test on a Thorneycroft boiler by Professor Kennedy which gave:

Incomplete combustion to hydrocarbons, and radiation	1.9
Incomplete combustion to carbon monoxide.	0.5
Sensible heat in the flue gases.	10.8
Available heat in the steam.	86.8

100 per cent.

device at all, but that on the second test the amount of sensible heat lost in the flue gases was diminished by seven per cent. through some slight and almost unnoticeable variation not connected with the device, while the loss by incomplete combustion remained the same. Thus although consideration of the efficiency alone might have indicated a saving, the complete tests show the device to be absolutely ineffective.

These methods of analysis may be applied to a question often discussed, namely, does heating the feed water by live steam from the boiler result in a saving of coal? It is obvious that heating the feed water cannot affect the efficiency of combustion of the furnace, nor can it affect the air supply per pound of coal. It is possible, however, that heating the feed water might, by improving the circulation of the boiler make the heating surface more efficient in transmitting the heat. If, therefore, we apply a live-steam heater and find that the efficiency of combustion (as shown by the heat balance) and the air supply per

pound of coal (as shown by the gas analysis) remain the same, but that the heating surface takes more heat out of the gases than before, (making their final temperature lower) then we may fairly ascribe the saving to the live-steam heater. Unless, however, we know that the efficiency of combustion and the air supply are the same there is no means of telling whether the saving was due to the live-steam heater, or to some other cause.

Although we may understand clearly the process by which the latent heat in the coal is transferred into the heat of the steam, and may know how to measure the different losses that occur in this process we cannot determine the best methods of running and building boilers except by making tests and comparisons of the many different types of boilers, and the different methods of running them. A series of such tests to be complete would involve thousands of trials at an expense which would run up in the tens or even hundreds of thousands of dollars, and no single boiler manufacturer or single organization of any kind can afford such an expense. The only method therefore is to take such tests made from time to time as are reasonably complete and accurate, and to draw such conclusions from them as we can. This is a work which I have performed in a paper before the American Society of Mechanical Engineers, and without going into the detail of the different computations, I shall give the general results which are as follows:

1st. In regard to radiation. The radiation depends only on the temperature of the outside of the boiler, so that the radiation when expressed in heat units should be nearly a constant amount, and the percentage that this amount bears to the total heat should diminish if the boiler is forced and the total heat increased. When, however, the results of tests on a great number of boilers were compared it was found that the percentage of the unaccounted for heat averaged about $9\frac{1}{2}$ per cent. whatever the rate of working, instead of varying when the rate of working varied, as would have been the case if the unaccounted for heat had been radiation. It was therefore clear that the radiation itself was very small in amount and that the unaccounted for loss must be due to some other cause, probably incomplete combustion.

It was important to determine what were the causes of incomplete combustion, and this was very difficult, since an error in any measurement affected this amount, and as a result the loss by incomplete combustion appeared to be very capricious, sometimes very high, sometimes very low. When, however, I omitted incomplete combustion to CO and considered only incomplete combustion to hydrocar-

bon I found by analysis and comparison of the tests a valuable indication. Whenever the conditions were such that the fire and the initial temperature of the gases were very high, the loss by incomplete combustion was very low. For instance, when the rate of combustion was very high, giving as is known by experience and has been shown by tests a very hot bed of coals, the incomplete combustion was low. When the rate of combustion was low the loss by incomplete combustion was high. When the fire was surrounded by hot brick walls, the incomplete combustion was low. When the fire was surrounded by the cold walls of the boiler itself the incomplete combustion was high. The results of individual tests were very capricious, but the general tendency was strongly in this direction, and further proof will probably be obtained when further experiments are made, and made with the necessary accuracy.

Loss by incomplete combustion to CO when measured directly turned out to depend closely on the air supply. If the air supply was less than one hundred and fifty per cent. of that theoretically necessary the CO loss began to appear, but several tests showed that with skillful firing the air supply could be brought down to and below this point without causing a serious amount of CO to form.

The loss in the flue gases depends on the amount of air used, on the evaporation per square foot of heating surface, and on the condition of the heating surface. The evaporation per square foot of heating surface is easily controlled, although in certain types of boilers the results clearly indicated that the gases short circuited and never came in contact with portions of the heating surface. Of course, this renders such portions ineffective, and throws more work on the rest of the boiler. The condition of the heating surface is also easily controlled by keeping it clear of soot on one side, and scale on the other. The amount of air however, depends on many uncertain factors. Comparison of many tests showed apparently that one of these was the rate of combustion per square foot of grate, and that if the coal was burned slowly say, less than 15 pounds of coal per square foot, per hour, the amount of air per pound of coal used was high, while if the coal was burned at a high rate, say, 30 pounds per square foot per hour, the amount of air used per pound of coal was low. The results of course, were capricious, there being tests on record which showed that a skillful fireman could burn the coal slowly and yet use only a small amount of air, and there is an indication that it is the ratio between the rate of combustion and the draft pressure that determines the air supply and not the rate of combustion alone. We will take up the question of

draft pressure later on, while we note here the interest of this fact which shows the cause of an opinion that exists in some quarters that boilers will not give the best results unless forced to a certain extent. The theory indicates, and we should naturally expect, that the more coal burned per square foot of heating surface the less would be the efficiency of the boiler. If, however, burning a large amount of coal per square foot of heating surface means also burning a large amount of coal per square foot of grate, the higher rate of combustion per square foot of grate will often coincide with a reduced air supply per pound of coal and in consequence the loss in the flue may be reduced sufficiently to balance the loss due to forcing the heating surface, so that the boiler when forced may be considered as a whole to show a better efficiency than when run at a moderate rating. This of course, would not be the case if the area of grate surface was reduced so as to burn the coal at a high rate of combustion without forcing the heating surface.

We will now return to the question of draft pressure and note that certain facts indicate that it is the ratio between draft pressure, or rather the square root of the draft pressure, and the rate of combustion that governs the air supply per pound of coal rather than the rate of combustion alone. The laws of hydraulics indicate that the total air supply should vary as the square root of the draft pressure. If, then the draft pressure is higher than is necessary to burn the coal at the desired rate, the air supply will be in excess and the loss in the flue large. Now the draft pressure available generally depends on the chimney and is frequently constant for all substantial purposes whatever the rate of combustion, so that unnecessarily high draft pressure, in proportion to the rate of combustion, and consequently excess of air supply would happen most frequently with low rates of combustion; and moderate air supply would accompany high rates of combustion.

The comparison of the results of the tests showed also that in certain types of boilers a great amount of air leaked into the gases after they had cooled down below the point of combustion, and that in some cases this leakage reduced the efficiency by as much as 10 or 15 per cent. Of course this loss does not occur in other types of boilers where it is impossible for such leakage to occur.

We, therefore, find that from the point of view of economy of coal, leaving out questions of safety, ease of management, first cost, etc., that the good boiler should have a large furnace lined with fire-brick where the temperature of combustion will be as high as possible, and thus the incomplete combustion will be as small as possible. In

this furnace a small grate should be provided on which the coal should be burned at a very high rate of combustion, 25 or 30 pounds per square foot. It is not practical however to go much beyond this rate, as unburned coke, coal and cinders will be carried up the chimney by the strong draft necessary if too high a rate of combustion is used. After the coal is burned in such a furnace the gases should be passed over a large area of heating surface, and this heating surface should be so arranged that no air can leak into the gases after the gases have passed into the flue.

Some of these conditions are incompatible with convenience of management, cleaning, low first cost, etc. For instance, the condition that there must be no air leakage either shuts out the water tube boilers and their acknowledged safety from any very destructive explosion, or else it involves bent tubes of the Thornycroft type which are hard to clean, or else it involves an air tight casing which is expensive. All these questions are beyond the province of the present paper. I have aimed only to show the factors that cause high efficiency, but have not tried to discuss the cases in which it is worth while to sacrifice other advantages in order to obtain high efficiency.

THE GREAT MAGNETITE DEPOSITS OF SWEDISH LAPLAND.

By David A. Louis.

SOME fifty miles directly north of the Arctic mining town of Gellivare, in Swedish Lapland, and about double that distance by road and river, is situated, at a latitude of $67^{\circ} 57'$, that remarkable range of heights known by the names of Kiirunavaara and Luossavaara. The position of this range of heights in relation to Gellivare and to the railway projected to connect them with that town in one direction and with the Norwegian frontier and seaboard in the other direction, may best be gathered by reference to the map, Fig. 1. This railway is to be single track, with crossings at the places marked by a circle on the map, and stations at Kiirunavaara-Luossavaara, at the frontier, and at Victoria Havn, in Norway; it

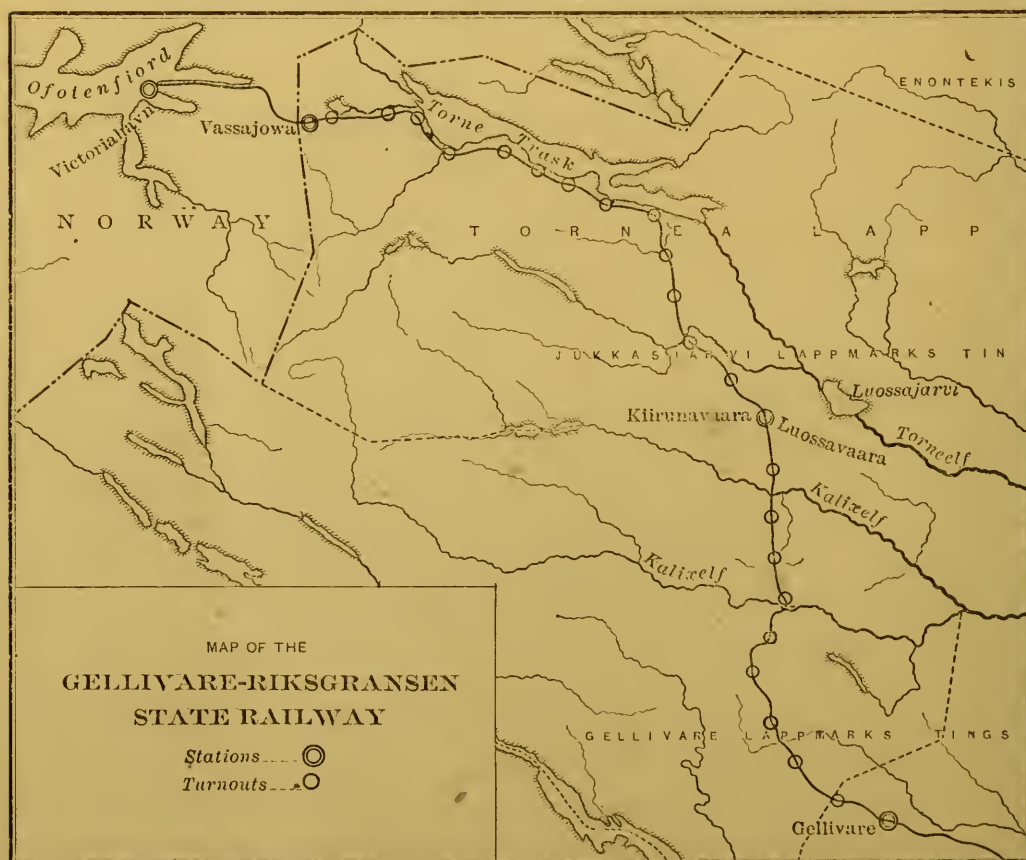


FIG. 1. SKETCH MAP OF SWEDISH LAPLAND.



FIG. 2. THE ROAD TO LUOSSAVAARA.

will make the distance from Gellivare 65 miles, from Lulea $188\frac{1}{2}$ miles, to the frontier about 82 miles, and to Victoria Havn, on Ofoter Fjord, $107\frac{1}{3}$ miles.

The range of heights in question is remarkable for the fact that the summits of the heights and the intervening ridges consist of a nearly unbroken outcrop of magnetic iron ore, an incident that had already attracted attention 200 years ago; and spasmodic attempts have from time to time been made to utilise this vast store of useful material, but without achieving any measure of success. This is not to be wondered at when one has made the acquaintance of the country and its roads. The country has climatic disabilities, and, moreover, consists mainly of swamps, marshes and lakes, with a few hills here and there. There is but scanty vegetation, thin forests of stunted trees, with an occasional birch or pine towering above like a giant in an assembly of dwarfs, and mossy and scrubby growth elsewhere. It is not the sort of country to attract a population, and as a consequence good roads are not wanted and are not to be found. At the present time, Kiirunavaara and Luossavaara are accessible from Gellivare by a route, the first stage of which is a very indifferent road, some 40 miles in length, touching on the way the small settlements of Murquivaara and Maskujäni, and terminating at Lappeasuando, on the Kaliz river. This river may be ferried and the journey be continued by road, but it

is preferable to take the boats or canoes and folks of the country and proceed up river. This is a broad stream of water, with a remarkable irregular bed, along which is distributed at frequent intervals a plentiful supply of boulders of varying sizes, so that with two passengers in a boat and three men to work it, paddling, sculling, poling and towing according to circumstances, the journey up stream proves a very laborious task, not devoid of excitement. Although only 40 miles has to be covered in this way it takes about two days to accomplish it, there being many stoppages for the men to rest and refresh, and in our journey Kiviniemi, the only inhabited place we passed, was made the halting place for the night. Homojänka is the landing place for Kiirunavaara, and thence a new road, 10 miles in length, leads to the little settlement that has risen around this scene of pioneering activity. Fig. 2 shows the new road at the approach to this destination, with the houses in the mid-distance, Lake Luossajärvi on the left, and the fine hill Luossavaara in the background. This, then, does not strike one as being a mode of transport suitable for the heavy traffic incident to iron mining, in spite of the fact that the journey down the river is done in eight hours.

It has been fully realised for a great many years that better communication should be had, but various obstacles have stood in the way of effecting any improvement. Ultimately, however, these have been removed, mainly by the energetic persistency of Consul G. E. Broms. Parliamentary powers have been obtained for the construction of the railway, which is to be completed within four or five years, and by that time, if we may judge from present state of things, all will be ready at the mines to get to work in earnest.

The district, as may be inferred from remarks that have already been made, has been the scene of many investigations, but the most thorough has undoubtedly been that conducted under the auspices of the Swedish Government by Mr. Hjalmar Lundbohm, who too has already given to the world in a special brochure and in an epitomised form in a paper before the Iron and Steel Institute (Vol. II., 1898), an account of some of the investigations that have been made at Kiirunavaara and Luossavaara. From these publications the following figures are borrowed. Fig. 2 is from a photograph sent the writer by Mr. Lundbohm. Fig. 3 is a panoramic view, obtained from the south-east, and shows the relative position and magnitude of the various prominences, which have been named to designate the various officials and assistants who have had a hand in the pioneering work. As a gauge of the size it may be noted that Statsradet is about 816 feet,



FIG. 5. ELECTRIC TRACTION IN OPEN-CAST WORKINGS.

Grufingenioren 584 feet, Bergmästaren 715 feet, Kapten 676 feet, Landshofdringen 781 feet, Professorn 783 feet, Jägmästaren 679 feet, and Luossarvaara about 751 feet above the lake Luossajärvi, which is about 1,640 feet above sea-level.

Fig. 4 furnishes the map of these deposits and their surroundings, and much information may be gathered from simple reference to it—that is, with the help of the conventional markings. Firstly, it will be observed that from the extreme south point of Jägmästaren to the continuation of the deposits on the island in Lake Luossajärvi indicates a practically unbroken stretch of nearly 3 miles of ore deposit in the Kiirunavaara range. The total length of the ore-body on Luossavaara is computed at 4,165 feet, and it does not appear to be connected with the Kiirunavaara deposit. Next it may be observed that the width of the latter deposit or deposits appears to vary from about 100 to 836 feet, while the deposit at Luossavaara does not appear so wide, the maximum width being about 200 feet. I say apparent width because as a matter of fact the actual width of the deposits is not as great as it appears on the surface, this exaggeration being due to erosic effects and the dip of the deposits.

A considerable proportion of the outcrop is freely exposed and

open to view, so that a walk over the ground gives one every opportunity of verifying the character of the material comprising the ridge and summits, while the existence of further non-exposed extensions of the ore-mass has been proved by means of the excellent system of magnetic surveying described by Professor G. Nordenström (*Iron and Steel Institute Journal*, Vol. II., 1898). The areas discovered in this manner are indicated on the map, Fig. 4, by cross-hatching. But the exploiters of these deposits have not restricted themselves to these means only to ascertain the character and extent of this great ore mass, for they have sunk or quarried no fewer than 184 test pits on Kiirunvaara and 14 on Luossavaara, many under the direction of Mr. Lundbohm, who in addition has directed and arranged a system of exploration by boreholes that has yielded important results, and from which still further weighty information is expected. On Fig. 4 the position and direction of the boreholes is duly indicated on the map, and in the lower portion of the figure some of the cross-sections revealed by these borings are set forth. These sections show that the deposits have a fairly constant dip of from 50° to 70° to the eastward on Kiirunavaara, and of 75° on Luossavaara the strike of the two being shown by lines A B and C D, respectively. The boreholes.



FIG. 6. SELF-ACTING INCLINE IN LAPLAND.

moreover, show that there are some indications of the deposits narrowing in depth; but however that may be as far as present investigations show the thickness of the ore mass between walls varies from 111 to 498 feet on Kiirunavaara and from 98 to 180 feet on Luossavaara, and in both cases the deposits are traceable to and below the level of the lake.

The available data, therefore, point to the quantity of ore above the level of Lake Luossajärvi, amounting to some 215,000,000 tons in Kiirunavaara and 18,000,000 tons in Loussavaara; or taken together there appears to be no less than 233,000,000 tons of ore in this district

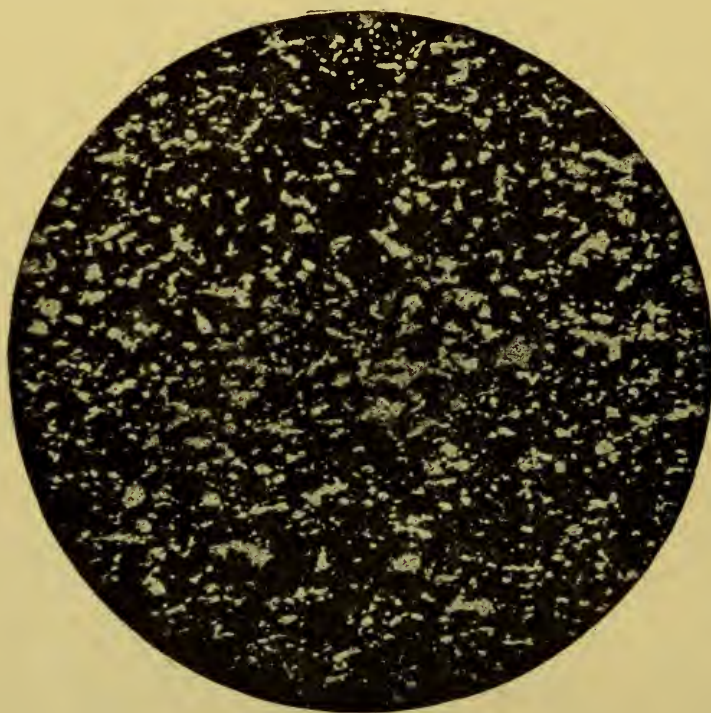


FIG. 7. MAGNETITE WITH DISSEMINATED APATITE.

above the level of the lake. There is very strong evidence indeed of large but unknown quantities of iron below that level; therefore taking into consideration the Swedish policy of moderation in mining, and the belief in the fostering as compared with the rapid exhaustion of their treasures, which it is proposed to adhere to in this instance, for the projected output from Kiirunavaara-Luossavaara is not to exceed 1,500,000 tons a year, so there are prospects of many years' activity in this inclement region. This fully justifies the construction by the State of the railway, shown in Fig. 1, and the proposed course of which through this iron district is indicated as going along the north side of Lake Luossajärvi in Fig. 4.



FIG. 8. TRAINS OF LOADED ORE TRUCKS, SVARTÖN.



FIG. 9. ELECTRIC STATION AND PHOSPHATE WORKS, SVARTÖN.

The systematic exploratory and tentative exploiting operations that are now being conducted have still another object in view—namely, the acquisition of such knowledge as will enable the engineers in charge to form a correct notion of the best method of working these deposits. There is no doubt that very considerable quantities of ore can be obtained from surface workings and for this purpose open-casts and self-acting inclines are contemplated, such as are in vogue at Gellivare, and are illustrated in Figs. 5 and 6. The former shows electric traction applied to the transport of broken ore in trucks from the open-cast workings to the head of the self-acting incline, of the character indicated in Fig. 6, which is used to lower the trucks of ore to rail level.

A personal inspection of the surface of the outcrop and of the country; of many of the test pits and quarried faces; of the sites of the boreholes, portions of ore, and of boring operations in progress, leads to the conviction that the character and magnitude of these deposits have in no way been exaggerated or misrepresented by the Swedish engineers engaged in the investigation of the property.

Taken as a whole the deposits consist of continuous bed-like masses of massive magnetite, situated between walls of porphyry or



FIG. 10. MAGNETITE SEPARATING HOUSE, SVARTÖN



FIG. 11. ORE AND COALING STATION, SVARTÖN. LULEA IN DISTANCE.

porphyritic felsite, that varies slightly in character. The magnetite at many points exhibits strong polarity, and generally is remarkably fine-grained, compact and hard. It is, however, traversed by numerous small joints, which render it sufficiently fissile to split into small pieces when blasted, but without falling to dust as the coarser-grained ore of Gellivare is apt to do. The magnetite near the walls is somewhat mingled with hornblende and chlorite, and at other isolated spots



FIG. 12. NEW ORE LOADING DOCK, SVARTÖN.



FIG. 13. MOUNT BLAGODAT FROM THE EAST.

with fibrous hornblende; quartz, talc, malachite, yellow mica, iron pyrites or tetanite are occasionally encountered. More frequently haematite and calcspar accompany the ore, while apatite is the prevailing admixture, and contributes the proportion of phosphorus that is so commonly found in these ores. This noteworthy freedom from admixture accounts for the high percentage of iron found in samples



FIG. 14 AN OPEN-CAST WORKING AT MOUNT BLAGODAT.

taken from the numerous pits and boreholes; the numbers obtained by Mr. Lundbohm from unpicked and unsorted ore are as follows:

In	7 pits, or	6 per cent. of the whole number, from	45 to 50 per cent. iron,
" 11	" "	" 12	" " " " " 55 to 60 " "
" 23	" "	" 21	" " " " " 60 to 67 " "
" 26	" "	" 23	" " " " " 67 to 69 " "
" 25	" "	" 23	" " " " " 69 to 70 " "
" 16	" "	" 14	" " " " " upwards of 70 " "

That is, more than 60 per cent. of the sampling indicates a percentage of iron exceeding 67, which, as a number for an ore field, and that a big one, is admittedly exceptionally good.

Then as regards phosphorus, 18 pits showed 0.05 or less, 18 between 0.05 and 0.1, 25 between 0.1 and 0.8, 15 between 0.8 and 1.5, and 32 between 1.5 and 6.0. That is, only 16 per cent. of the sampling shows the lowest proportions, such ore being encountered in workable quantities at the Vaktmästaren, Landshöfdingen and Professorn hills. The rest is generally higher phosphatic, and in fact about 30 per cent. of the sampling indicates a proportion of phosphorus coming within the highest limits. The percentage of sulphur has in a few instances reached 0.1, otherwise it never exceeds 0.088, and generally is about 0.05, or sometimes even less than 0.02. Tetanium occurs in some parts, and has been found to the extent of 0.32 to 0.95 per cent., while of manganese there is very little—that is, it is not above 0.32 per cent.



FIG. 15. A SELF-ACTING INCLINE AT MOUNT BLAGODAT.

The number given refer to Kiirunavaara, but with slight variation may be taken as representative of Luossavaara as well.

To give some further idea of the character of the ore the following numbers are given; they are the results obtained from the complete analysis of samples of sorted ore, ore from Vakmästaren on Kiirunavaara, the other from the summit of Luossavaara. The numbers are per cent.:

	—Iron ore from—	
	Kiirunavaara.	Luossavaara.
Magnetic oxide of iron.....	96.25	71.15
Ferric oxide.....	1.62	25.32
Iron.....	70.80	69.23
Manganic oxide.....	0.26	0.26
Lime.....	0.40	0.30
Magnesia.....	0.31	0.22
Alumina.....	0.39	0.56
Silica.....	0.95	1.85
Phosphoric acid.....	0.008	0.086
Phosphorus.	0.004	0.037
Sulphur.....	0.033	0.03

As will be seen, the composition of the ores is similar, and so is their character. A word may perhaps well be added concerning the phosphorus; it is, as I have already stated, not in the magnetite but in the associated apatite, as is the case in Gellivare. In the present instance it is sometimes distributed in segregated masses, at times forming great isolated patches, at other times making a kind of stockwerk with the magnetite, while in yet other cases it is so finely divided and evenly disseminated as to make an intimate mixture with the magnetite as shown in Fig. 7, which is a photograph of a thin section of such ore enlarged 39 times—that is, from the size of the adjoining dot. This explains the anomaly of an apparently pure ore containing as much as 3 to 6 per cent. of phosphorus.

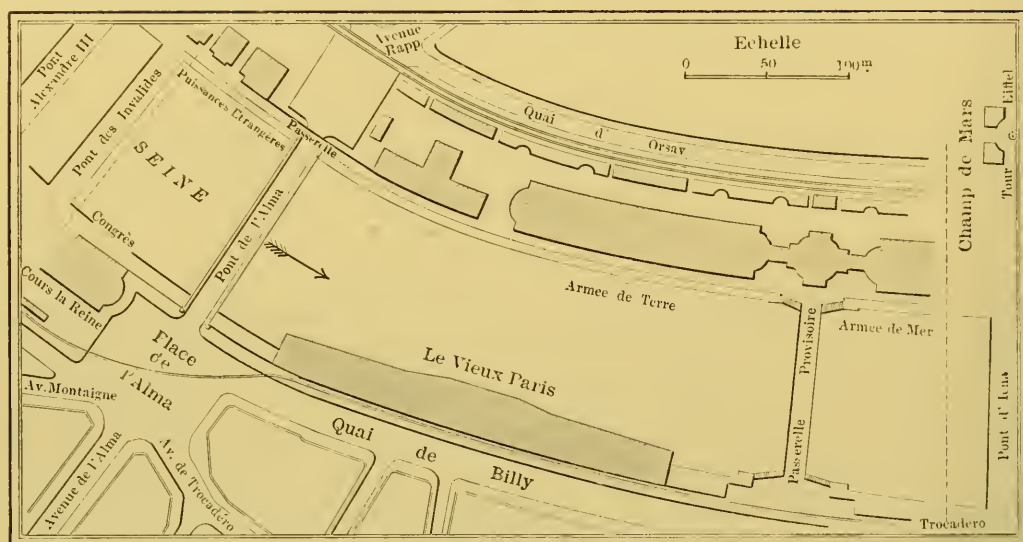
THE BUILDINGS OF THE PARIS EXPOSITION OF 1900.—II.

By Jacques Boyer.

ALTHOUGH a very notable part of the Exposition of 1900 is to arise along the shores of the Seine, we cannot at present say much about these buildings, with exception of the Aquarium, "Old Paris" and "Les Bonhommes Guillaume," which are undertakings in the nature of private concessions. We may, however, outline the various projects which will arise along the shores of the river during the coming year. On the left bank, near the Eiffel Tower, the Forestry Pavilion will be built; here also will stand the building dedicated to Navigation and Commerce, as well as the Foreign Government Buildings. A photograph taken at the present time shows that so far only the platform has been laid, while the plans elaborated by the Commissioners of each nation still await approval by the French administration. On the right bank the colonies of France and those of foreign nations will occupy the ground in front of the Trocadero. Here only the foundations have been begun. The Aquarium and "Les Bonhommes Guillaume" are not within the scope of this article, but there remains the contemplated reproduction of "Old Paris," the construction of which is sufficiently advanced to merit a passing notice. As shown on the plan, the buildings comprising "Old Paris" will extend from the bridge of Alma to a temporary passage way thrown across the river above the bridge of Jena, to provide a passage from the Army and Navy Buildings to the Quai Billy. The plans for "Old Paris" were made by the eminent artist Robida,* who has here undertaken to design, with the aid of many old documents, the most picturesque edifices of the French capital of times gone by.

By means of an embankment extending out into the Seine, the space available was enlarged to a grand total of 6,000 square metres. The panoramic view of the scheme shows the general effect, and among the actual reconstructions contemplated we may cite the Porte St. Michael, the birthplace of Molière; the Bureau of

* M. Robida has kindly permitted the reproduction here of some of his designs, which courtesy we take pleasure in acknowledging.



PLAN OF THE BUILDINGS ALONG THE BANKS OF THE SEINE.

Information of Theophrasto Renaudot, founder of the first French journal; the Place du Pré-aux-Clercs; and the Tower of the Louvre, the Grand Châtelet, the Rue des Vieilles Ecoles, etc., etc. In a word, it is proposed to recall, in its popular, commercial, or industrial aspect, the life of Parisians during the seventeenth century, in the setting and costumes of that time.

The work of building the foundations for "Old Paris" was finished some time ago under the direction of the engineer, M. Benonville, and are sufficiently interesting to demand notice. The available area being very limited, piles were driven into the river bed in order to extend the width of the platform to about twenty-two metres. In the middle an additional projection over the river increases this width to twenty-nine metres. About 900 pine piles, one metre in circumference and from ten to fifteen metres long, were driven in the usual way, their lower ends having first been provided with a pointed wrought iron shoe to permit their being driven into the river bottom. Owing to the character of the river bed, this was an operation of some difficulty, some of the piles requiring



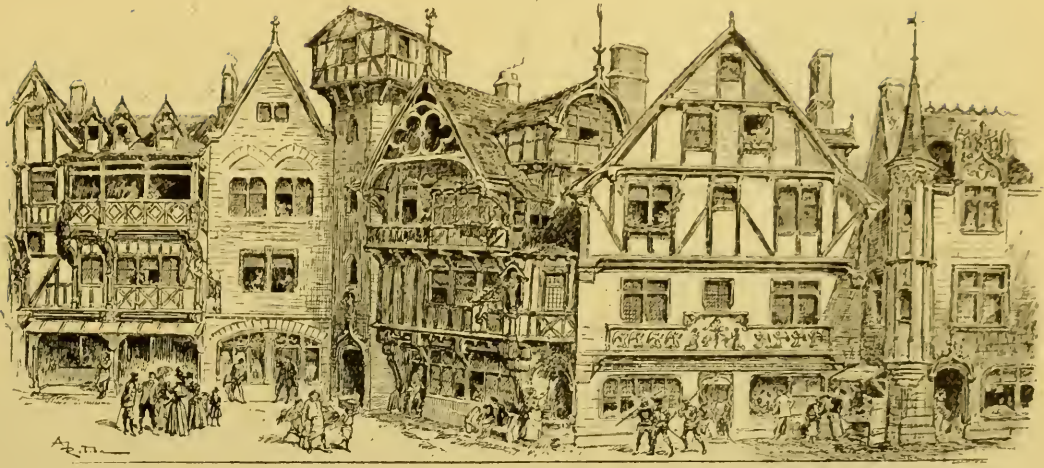
SECTION OF THE PLATFORM SUPPORTING "OLD PARIS"



A GENERAL VIEW OF "OLD PARIS."



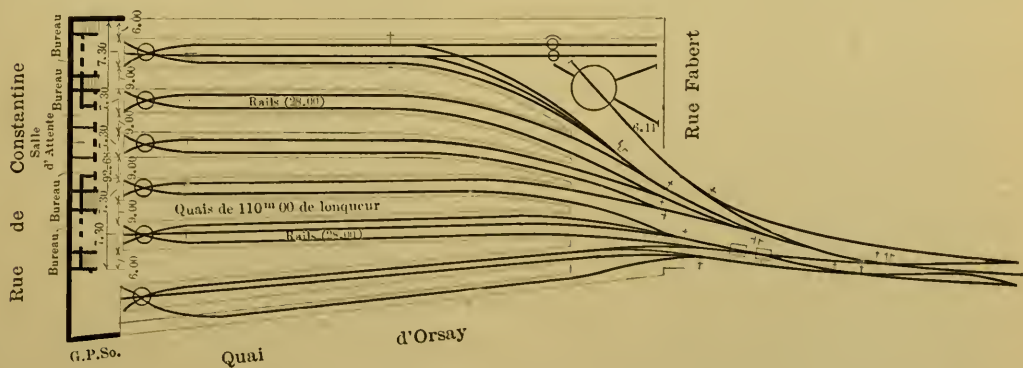
THE ENTRANCE TO "OLD PARIS," PORTE ST. MICHAEL, MARCH, 1899.



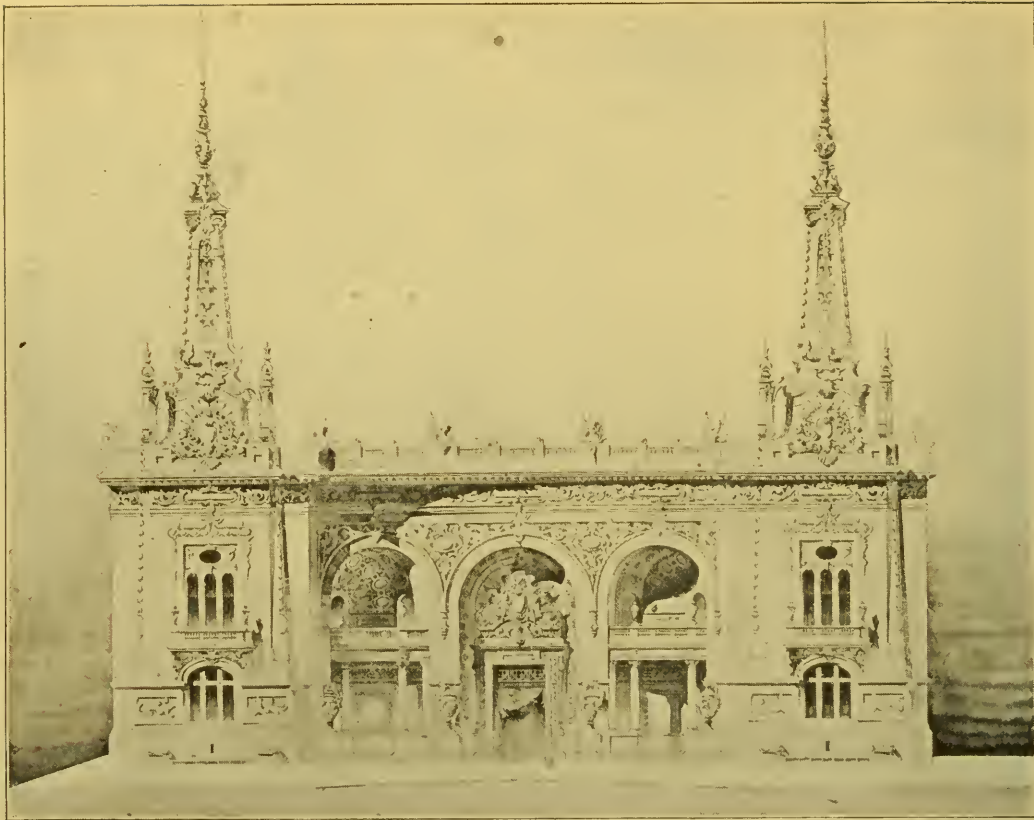
RUE DES VIEILLES ECOLES "OLD PARIS."

as many as 500 blows to be sunk a distance varying from two to six metres, according to the location.

The profile of the slope at different points was determined by preliminary surveys, the one reproduced in the engraving being about the middle of the platform, the level 27.00 being the normal datum at the barrier of Suresnes. In order to increase the stability, the piles are framed together by four courses of horizontal timbering, running longitudinally and transversely, there being a framing of riveted steel beams above and a flooring of heavy pine planks. The platform is computed to sustain a loading of 4,000 kilogrammes per square metre. This substructure alone has cost 500,000 francs. The design and decoration of the superstructure will cost much more than this, as it is the intention of the authors of the project to make the historical reproductions as accurate and artistic as possible. There is no doubt that this feature of the Exposition will be a great success, and we may venture to predict that



PLAN OF THE INVALIDES RAILWAY STATION.



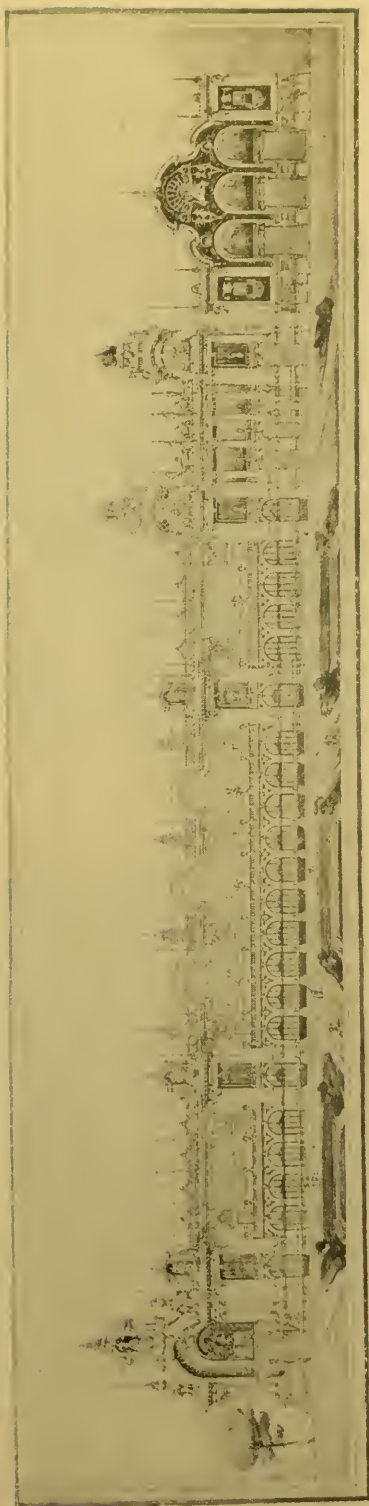
THE CENTRAL PALACE OF THE ESPLANADE DES INVALIDES.

the inns of "Old Paris" will overflow with noisy "Escholiers," rather than with grave "Docteurs-en-Sorbonne."

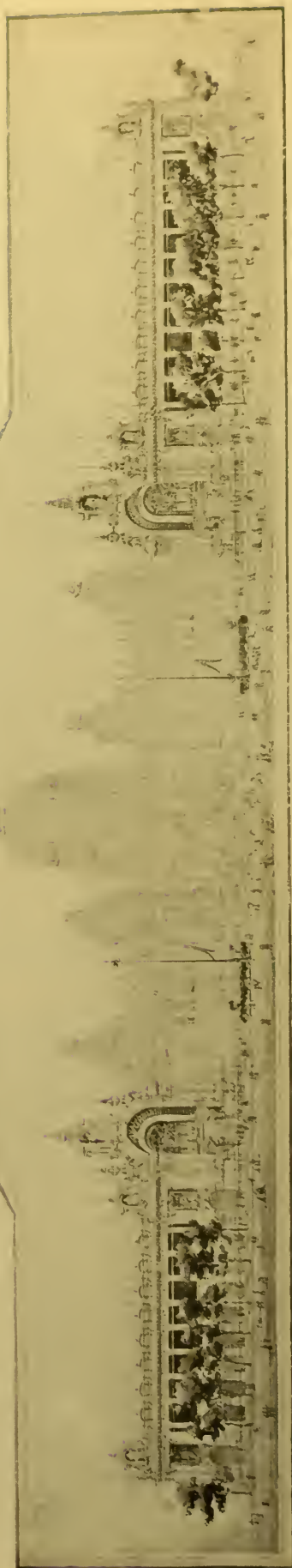
Regarding the Horticultural Building and the exhibit of the City of Paris, both of which face the pavilions of the foreign powers, but little can be said at the present time, as their construction is not very far advanced. There will be ample time for their construction, however, as they are of a design which admits of rapid work, especially the Horticultural Building, which, in fact, will form a vast hot-house, covering an area of four square kilometres and costing 700,000 francs.

We now come to the buildings upon the Esplanade des Invalides, including the new railway station.

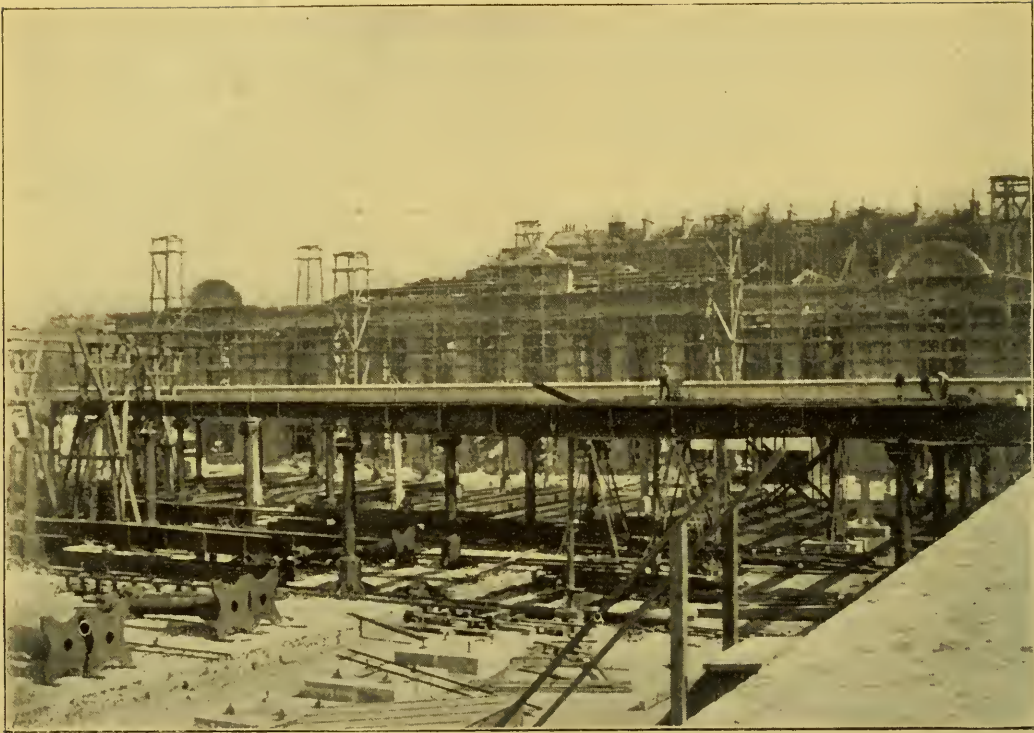
While these buildings present no extraordinary features, they offer much that is of interest, really more than we can fully describe in the limited space available. We can only mention the ingenious scaffolding and hoisting apparatus designed by the contractor, M. Leclair, and refer to the extensive plans which have been made for the improvement and decoration of the future avenue which is to form the prolongation of the Alexander III.



THE NATIONAL MANUFACTURES BUILDING



THE GALLERIES OF THE INVALIDES RAILWAY STATION

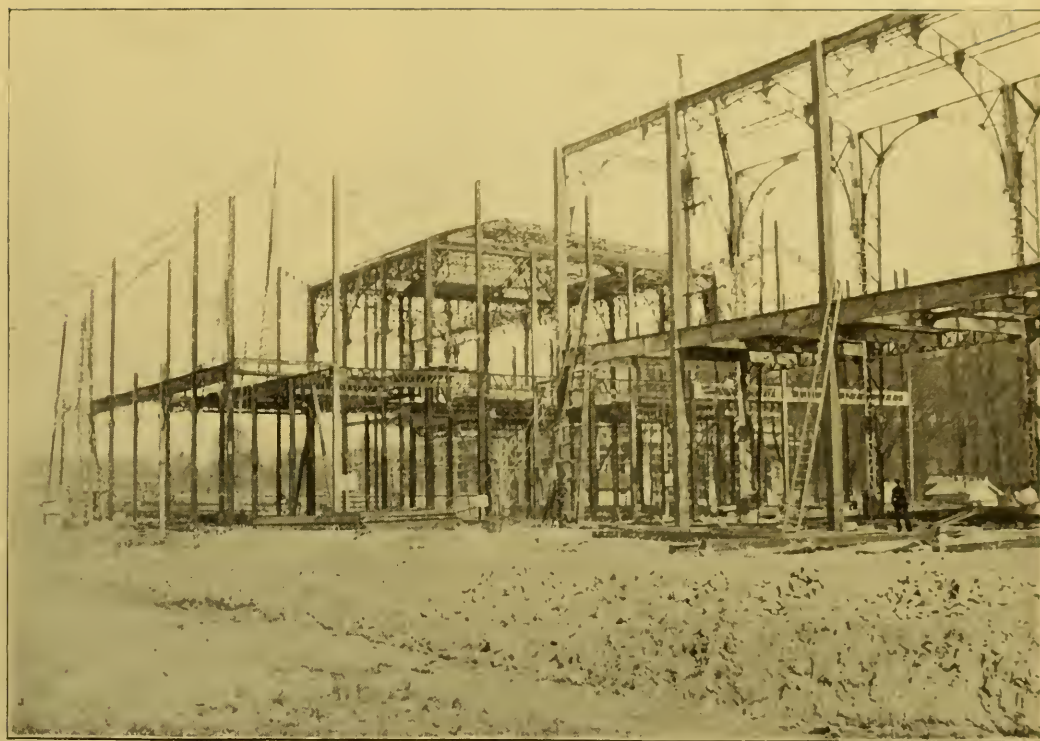


THE WORK ON THE INVALIDES RAILWAY STATION.

bridge. While these various structures have been entrusted to different architects, among whom we may mention MM. Toudoire, Pradelle, Esquié and Tropey-Bailly, the endeavor will be made to secure harmony in general effect, although designs of various styles are to be adopted.

Among the illustrations are shown the National Manufactures Building and the Galleries of the Invalides Railway Station, and also a view of the latter structure showing its state of advancement in April, 1899. Most of the buildings upon the Esplanade des Invalides are to be provided with galleries similar to those in the buildings on the Champ-de-Mars, and in these galleries, to which ready access will be given by stairways, elevators and traveling platforms, will be placed restaurants and many exhibits and other attractions. The whole arrangement of these buildings compares most favorably with those of 1889, the arrangements for illumination and ventilation being far superior.

We shall now proceed to the new railway station of the Invalides. The Western Railway of France already possessed a terminal on the left bank of the Seine, by the Champ-de-Mars. This was the end of a local line connecting at Puteaux with the Versailles Railway of the right bank. It was decided some time



THE INVALIDES RAILWAY STATION, APRIL, 1890.



PLATFORM FOR THE NAVIGATION AND COMMERCE BUILDINGS.



M. ALFRED PICARD, COMMISSIONER GENERAL OF THE EXPOSITION OF 1900.

ago to move this station to a point nearer the centre of the city, and this project was hastened in anticipation of the great crowds which are expected during the Exposition. The important roadway construction works which this extension involved cannot be described here, but must be reserved for another time, and we shall confine ourselves only to the new station building.

In the design of the station it was required of the engineers that they should encroach as little as possible upon the grounds, as it was desired to avoid obstructing the fine view, while at the same time it was important to provide sufficient accommodations to meet the heavy demands of the service.

The plan view of the station shows how this problem was solved. A vast underground hall, of a mean width of 110 metres, extends for a length of 220 metres between the Rue de Constantine and the Rue Fabert, proving an area of nearly 25,000 square metres, or more than double that of the new station of the Orleans company at Quai d'Orsay. This underground station will contain thirteen tracks, with suitable platforms, of 170 metres in length.

The terminal building of the station, containing the waiting rooms, offices, etc., is situated on the Rue de Constantine, facing the Ministry of Foreign Affairs, and being but one story high and surrounded by trees will not be conspicuous. Several stairways will communicate with the underground platforms, and above ground the two wings of the building will be designed in the style of Louis XIV., in order to harmonize with the adjoining Hotel des Invalides. The subway containing the tracks will be covered with a metal platform providing a roadway of twenty metres in width, and forming on the left a continuation of the Alexander III. Bridge, the openings for the railway beneath being screened by the foliage of small gardens.

In this rapid survey of the buildings of the Exposition of 1900 we have necessarily passed over many things which, while attractive in themselves, would demand too much space to describe here. Among these we may name the gigantic telescope, the building of the Alpine Club, "French India," "Andalusia in the time of the Moors," and others, all of which will doubtless occupy much of the time of visitors in their inspection, but which are only distantly related to the art of engineering.

In area covered, in boldness of conception, in beauty of design and grandiose aspect of buildings, the Exposition of 1900 will far surpass its predecessor of 1889.

We cannot conclude without paying our tribute to the organizer and master mind of this great Exposition, to M. Alfred Maurice Picard, the Commissioner General. May the active energy of which he has given so many proofs extend to all of his collaborators, to the end that the coming Exposition may be formally opened at the appointed time, for there is not a moment to be lost if this much desired result is to be attained.

THE EVOLUTION AND FUTURE OF THE GAS ENGINE.

By Georg Lieckfeld.

WHEN comparison is made between the operation of the gas engine and that of the steam engine, one wonders how it happens that the invention of the steam engine preceded that of the gas engine by a whole century.

Gas explosions, with their very considerable development of force, were known long before the invention of steam engines, and one would suppose that these explosive phenomena would have been earlier studied and harnessed for work than the less obvious plan of artificially converting water into steam, especially as gas explosions occurred in the industrial occupations followed by the able men who did so much for the creation of the steam engine.

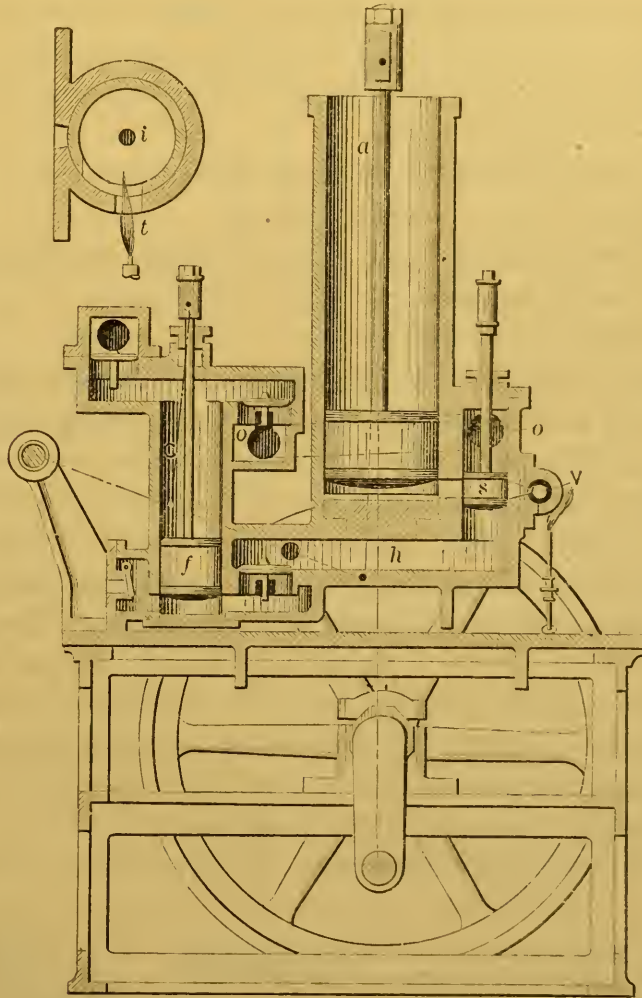
When lockmakers and smiths used bellows on their forges they well knew from experience that under certain conditions the bellows exploded with a loud report, for, if bellows are not used on a freshly covered fire, there thus being a deficiency of oxygen, the coal does not burn to CO_2 but to CO , and this gas having no other outlet, works back into the bellows through its nozzle, and becoming diffused through the air in the bellows forms an explosive mixture, which, when the bellows is started up again, is blown into the fire, ignites, flashes back into the body of the bellows, and either blows it to pieces, or with loud report finds outlet through the nozzle, scattering the burning coals.

In many other cases, as in blast furnaces, explosions have been observed, the gas being formed in a similar manner.

Notwithstanding the fact that gas explosions were observed centuries ago, no one understood how to utilize them. It was only after illuminating gas had been in use quite a long time that anyone began to think of mixing gas with air, to explode this mixture and use its power to drive an engine.

Patent records have been called a manual of the history of inventions, and in such records we find that William Barnett, an Englishman, was probably the first (in a patent specification of 1838) plainly to claim the broad principles which still govern explosive gas engines. Barnett describes three different engines, one of which is here illus-

trated. In the drawing *a* is the working cylinder, *c* the air pump and behind this lies the gas pump, not visible in the illustration. These two compression pumps force air and gas into the loading chamber *h*. When the working piston is on the lower dead center the piston valve *s* opens and connects load chamber and working cylinder and also opens the ignition inlet *v*, the claim being that the flame *t* ignites the charge.



BARNETT'S GAS ENGINE.

After the piston has been driven by explosion to the upper dead center, the slide valve *s* goes down, opens connections between *o* and the upper side of the air pump *c*, which is also descending, and thus the products of combustion are drawn from the working cylinder, and, on the up stroke of the air pump piston, expelled from the engine. Barnett finally claimed that it was not necessary to draw out the burnt gases, but that they can escape into the open air through a valve.

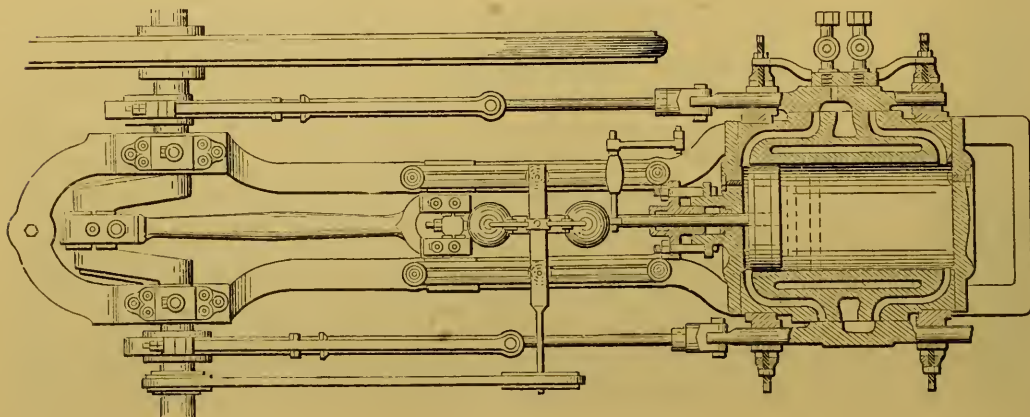
In describing variations of his engine, Barnett also claimed ignition by means of platinum sponge, which glows the more readily because of the compression of the gas mixture.

From the great number of variations described, both for engines and ignition apparatus, it is evident that Barnett was well aware of the value of his invention, and was attempting in his patent specifications to cover all possible forms. Although the gas engine designers of the present time can see plainly that Barnett's design would not have produced a practical working engine, nevertheless it must be emphasized that Barnett's ideas include all that is fundamental in the theory of the modern gas engine :

1. Compression of the gas mixture before ignition.
2. Combustion in the working cylinder.
3. The dilution of the gas mixture with combustion products remaining in the load chamber.
4. Ignition on a dead center.

After this first effort to design an operative gas engine, there was a long period of inactivity. The clearly expressed fundamental ideas of Barnett's specifications were forgotten, and not until 1860 was the first gas engine made ; one which actually worked and which to some extent was practically used ; namely, that of the Frenchman Lenoir. Although the principles used by Lenoir for his engine had not the fundamental value of those of Barnett, nevertheless to Lenoir must be conceded the great merit of being the first to whose patience and energy we owe a practical solution of the problem of the gas engine. He may, therefore, rightly be considered as the inventor of the gas engine, for, it is an immeasurably greater merit to carry into execution a creative thought than merely to apprehend it.

As shown in the illustration, the Lenoir engine in outward form



LENOIR GAS ENGINE.

and method of utilizing expansive power, closely resembles the steam engine. On the part of the outstroke, the piston draws in the gas mixture until the dotted position is reached, when the gas is ignited by an electric spark, and the piston is then driven the short remainder of the stroke by the force of the explosion. On the return stroke the same operation is repeated. The Lenoir gas motor was therefore a double acting engine without compression.

Lenoir made many attempts to improve his engine, especially to reduce the great consumption of gas. For instance he used as dilute a gas as possible, but in order to be sure of ignition, a richer gas was injected at the last moment, near the spark. He also attempted to use a jet of steam, hoping through it to prevent the very rapid fall in pressure after explosion.

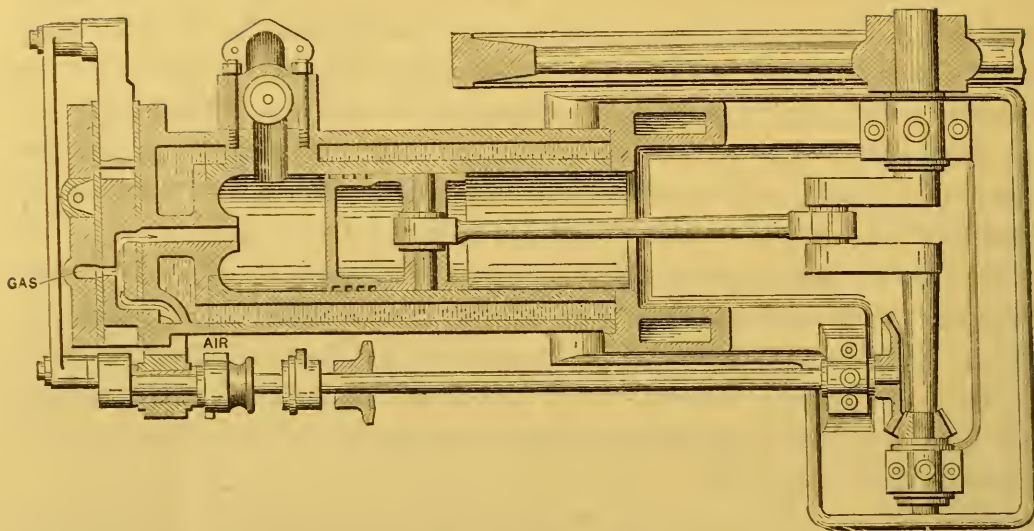
Twenty-six years ago the writer had the privilege of watching a Lenoir gas engine at work driving a spinning machine, and although it was on the second story of a dwelling, it worked in absolute silence. The operating costs of the engine were, however, very heavy, the consumption of gas being three cubic meters, or about 106 cubic feet, per horse power hour, or six to eight times the requirement of the best modern gas engines, even larger relative quantities of lubricating oil being also used.

Almost immediately after the appearance of the Lenoir engine, Gustave Schmidt published in the year 1861 in the *Zeitschrift des Vereines deutscher Ingenieure* a study of its theory, and he showed how its efficiency might be very greatly increased by compressing air and gas before combustion in the engine. Although Barnett had designed his gas engine in 1838 for a compressed gas mixture, this fundamental principle was but very slowly introduced in practice.

Hugon made an attempt to increase the efficiency of a Lenoir engine by a spray of water at the instant of explosion, hoping to utilize in the making of steam a part of the heat so suddenly and wastefully set free, and thus secure a more uniform pressure than that to be obtained from the very hot gas combustion.

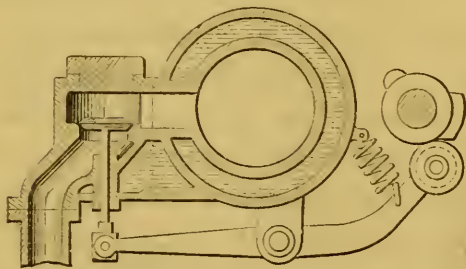
The next step was the atmospheric gas engine by Otto and Langen of Deutz, near Cologne, Prussia, in which advantage was taken of the rapid evolution of heat at the moment of explosion to drive an easily movable "flying piston" and indirectly to utilize the vacuum under the piston to draw it down again while doing work.

Full fifteen years went by before the value of compression was remembered and it was N. A. Otto, of the above firm of Otto and Langen, who *built* the first compression gas engine. It is well known that



OTTO GAS ENGINE.

Otto used the two stroke cylinder in his first compression gas engines. He added to the working-cylinder a mixing-pump which drew in the air and gas mixture, *compressed* it and forced it over into the working cylinder. This style of motor was not a practical success, and it is to Otto's credit that he was the first to introduce the *four stroke* principle in gas engines. The first stroke draws in the gas mixture, the second compresses it, explosion follows and work is done during the third, and the fourth stroke drives out the burnt gases. This principle is the governing one in the plan and construction of all gas engines on the market to-day.



SECTION OF OTTO CYLINDER.

The engravings show an Otto four stroke compression gas engine. The working cylinder is closed at one end only, and this closed end extends beyond the stroke and serves as a reservoir chamber for the compressed charge. The piston draws in, on its forward stroke, the mixture of gas and air, the inlets being marked by the arrows. On the return stroke this mixture is compressed. During both of these strokes the engine is doing work as a pump. Just before the end of the compression stroke, before the piston has quite reached the dead center, the slide valve at the back of the load chamber is opened and permitting ignition; explosion follows, and the piston is driven forwards with great force. At the end of the stroke the exhaust valve

is opened and permits the escape of the burnt gases into the open air, and the piston moves into its first position, thus forcing out the remnant of the burnt gas, except what remains in the clearance chamber.

The clearance chamber is filled with burnt gas, which fact must not be overlooked. The fresh charge is mixed with these products of combustion which consists mainly of steam and carbon dioxide. It is only in the inlet passage between load chamber and valve that there is no adulteration of the charge, and during the whole suction stroke this inlet is filled with pure gas mixture, while the chamber is charged with adulterated and diluted gas, difficult to ignite and slow to burn. This design adds to the reliability of ignition, and we must also give it credit for its silent, even running, absolutely free from jerks or blows, and very great gas economy. In the Otto patents the greatest importance was claimed for the inlet passage, connecting the ignition chamber with load chamber. It was named the shot inlet, because the pure explosive mixture contained in it was counted on to burst forth like the flame from a gun into the combustion chamber, a reliable and complete combustion of the whole load resulting. These Otto patents, among other things, prevented others from using, without infringement, a cylinder lengthened beyond the piston stroke, with a communicating inlet between ignition and load chamber. Many suits have been instituted in all civilized countries to protect these patents upon which a monopoly of gas engine building virtually depended.

In Germany these patent suits dragged their weary length from 1878 to 1892.

To-day it is generally acknowledged that the shot inlet and also other claims of the Otto patent are not as important as was imagined. The ignition point is no longer placed in the inlet passage, but directly in the load chamber, the necessity of having an ignitable gas mixture there naturally following. The sudden burst of flame of the Otto arrangement from the inlet into the load chamber is omitted, yet good combustion is secured.

One would imagine that the extraordinary improvement effected by the use of compression in gas engines, would have led to further progress along the road first followed with such success by Otto, but this was not immediately the case. Ten more years passed before anyone dared to use higher compression than the 3 to $3\frac{1}{2}$ times, which Otto employed.

About 1887 the brothers Korting of Hanover built gas engines which worked with compression of 4 to 5 atmospheres, and the favorable economy in gas secured by this increase made everybody realize

its extreme value, and forthwith engines were everywhere built with high compression.

Among others, the engine designed by Banki, and built by Ganz & Co., of Budapest used compression to 6 and 7 atmospheres and the gas engine "Charon" built by La Société Nouvelle des Moteurs à Gaz of Paris, uses $7\frac{1}{2}$ atmospheres. To-day gas engine builders do not hesitate to use 10 to 12 atmospheres. With this increase in compression there has been a simultaneous increase in the rate of revolution of the fly wheel and an increase in the area of valves.

To these developments belong the main credit for the increased efficiency of fuel consumption in gas engines.

Another element which has stimulated gas engine building is the invention and perfection of apparatus for the making of producer and other gases, introduced by Emerson Dowson, an Englishman, about 1885. With the help of these very simple, cheap and easily operated producers which render 80 per cent. of the heat units in the fuel used, gas engines have passed beyond the stage of small engines and may be said to have begun to compete with steam engines of the largest size; not only because they are independent of central gas supply, but also because they utilize to higher degree the energy in the fuel, and can be run with a minimum of labor.

Up to the present time, whenever power is to be obtained from a heat engine, the piston engine has proved itself the best and most efficient.

In order that the heated gases may be used to the fullest extent possible, their expansive power should be expended at the end of the piston stroke, and as much as possible of the stored heat contained in them converted into work and as little as possible of the heat be lost by radiation.

With the steam engine an efficiency of 13 per cent. to 15 per cent. of the theoretical heat units in the combustible may be realized. A gas engine of best construction converts 30 per cent. of the theoretical heat of the illuminating gas used into work. It must however in this comparison not be forgotten that the fuel used in a gas engine is refined or purified, while in the steam engine furnace the raw material is pitched in as it comes from the mines. Since however the Dowson producer converts over 80 per cent. of the theoretical heat in the raw fuel into a gaseous form, which can then be used in a gas engine, we have still for the gas engine a practical efficiency of 24 per cent. But we must again remember that this high efficiency of the gas engine occurs only under full load, and that the yield in work from the

combustible falls off in a very marked degree under partial load. This serious drawback to the gas engine can be explained by the following considerations.

As already mentioned, the economic employment of a piston demands that with the end of the stroke the expansion of the hot gas shall have reached its limit. This condition can only be satisfied by a gas mixture of certain proportions used as the charge, which can be calculated from the volume of the cylinder, the gas to be injected into it, the volume and nature of the burnt gas products in the charge chamber. Only in certain definite proportions of air and gas is the mixture most efficiently burned. Any change of proportion, whether gas is increased or diminished, or whether the residue of burnt gas is changed in quantity, immediately causes much less effective combustion. In the usual type of gas engine it is not possible to lessen pro rata both gas mixture and residual burnt gases. In every case, if less gas mixture is drawn into the engine, a charge results which not only gives less initial pressure, but also burns more slowly, giving higher final pressures. In this inevitable slower combustion there is also inevitable diminution of efficiency with anything less than full maximum load. Gas engines can therefore not be governed advantageously, as steam engines are, by cutting off the supply of gas (steam); but the builders, in order to save gas and yet lessen load, solve the problem by omitting explosions so that the engine is always driven with a full charge, and best combustion, even if these charges do not occur so frequently. That such governing is at the expense of uniformity and regularity needs no demonstration.

If regularity is absolutely essential, there must be a larger allowance of gas, and in that case the engine can be governed by diminution of load charge or by lessening the relative and essential proportion of gas, but in each case using more gas than the reduced load would seem to require.

As it has been discovered that the composition of the charge must remain unaltered, for highest efficiency in case of lighter load, economical and efficient governing is best secured by using a smaller number of charges. The smaller the size of the combustion chamber in an explosion engine, the smaller the quantity of residual burnt gases, and the less their diluting influence on the charge. As size of combustion chamber diminishes with increased compression, it follows, and this has also been verified in practice, that gas engines with very high compression show better economy under variable load than those of low compression, if both are regulated by variation in volume of charge.

From all this it follows that the gas engine is very far from satisfactory in its ability to proportion combustion to work done, and that this cause of deficiency is inherent in an explosive engine. To govern an explosive engine by gradual diminution of the charge, it would be necessary to diminish the residual burnt gases, and thus far this has not been accomplished in a sufficiently simple manner.

Attempts to use other modes of combustion than explosion, in heat engines, so as to control better the process of combustion are therefore quite justifiable, and have caused the invention of the so-called combustion engines as opposed to explosion engines.

In the explosion engines the combustible and the necessary air are stored *fully mixed* in the combustion chamber, ignition takes place on one plan or another from without, and combustion follows, according to the nature of the substance. In the combustion motors, combustible and air are introduced *separately* into the working cylinder and ignition takes place at the particular moment when the two substances meet. Air and combustible are not mixed in advance, but the rapidity of the combustion varies according to the proportions of each admitted. If larger quantities of both are used, more power is obtained than if lesser quantities are used in the same proportion. The gases, products of combustion, are wholly expelled and therefore do not affect the result.

It is plain that this kind of burning can be better controlled than explosion, for, in the latter case it is not possible to control in the same way the composition of the load.

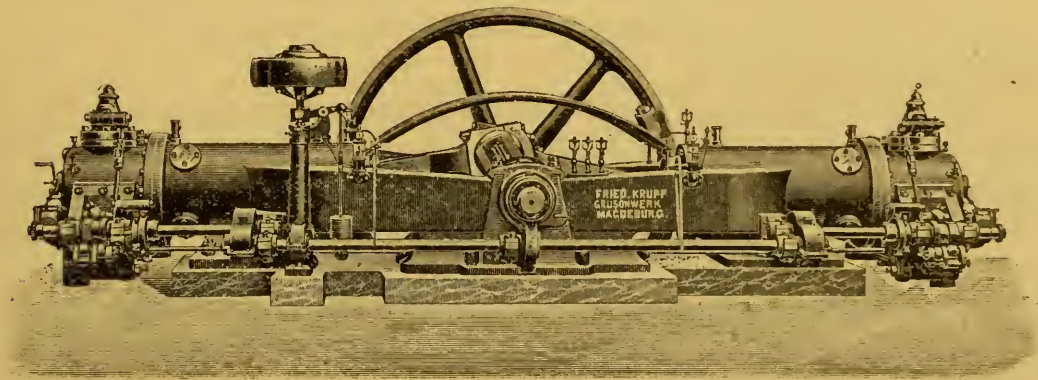
Combustion engines were invented almost as early as the explosive engines, and their development and design will form the subject of a subsequent paper.

The four stroke compression engine, as built by Otto in 1876, has shown itself a reliable, safe, durable engine which in the course of time has, in all its parts, been very greatly perfected. By increase of compression and more rapid revolution of the fly-wheel, by increased opening of the valves and suitable proportions to the combustion chamber a high degree of efficiency has been attained, the gas consumption having been very greatly reduced. Gas engines are now built in medium sizes using about 430 (12.7 cu. ft.) liters of illuminating gas, equal to 2,150 calories (8,531 B.T.U.) per horse power hour.

That gas engines of large sizes and great power, equal to the largest steam engines can be built, and are in the future to be counted among the standard power engines, is already proved by many examples. In France there is a single cylinder gas engine at work

developing over 480 H.P. There are in Germany single cylinder gas engines of 170 H.P., which have been working steadily for a long time without trouble of any serious kind. The illustration shows a 300 H.P. gas engine built by Fr. Krupp. In England and the United States it is reported that even larger gas engines are at work. It is especially iron furnaces which can make enormous use of gas engines as they are in a position to supply all the fuel necessary by using the waste furnace-gases.

When there are as competent engineers for gas engines as there are for steam engines, the unfounded complaints about their unreliability will vanish and the conviction will become more general that gas engines are not only cheaper and more economical to operate than steam engines, but that they are also very much more convenient. Steam engines have been perhaps perfected to the utmost limit, but



KRUPP GAS ENGINE. 300 H. P.

this is not yet the case with the gas engines. Means will be found to build double acting four stroke gas engines which will be as reliable as the single acting engines now are. It has also been proven possible to increase compression in the explosion engines to an even greater extent than 12 atmospheres without risk of premature ignition.

It will also be possible to build internal combustion engines on the Brünter or Diesel models in perhaps improved form, and these, in economy of fuel and accuracy of governing may yet surpass the explosion engines.

Finally we may mention a peculiarity of gas engines which has never been satisfactorily explained, namely the fact that increase in size in the explosion type does not lessen fuel consumption to the extent that one would expect. The very best economy ever attained, 430 liters (12.7 cu. ft.) illuminating gas per h.p. hour, was in a 15 h.p. engine, the writer knowing of no instance surpassing it among

the larger engines. Some designers are of the opinion that internal friction increases out of proportion in the larger sizes, due probably to the difficulties of adequate lubrication of the long and heavy piston.

Others who use less compression in the larger sizes than in the small models ascribe the evil solely to this fact, and they have avoided the higher compression owing to the danger of premature ignition.

The writer's opinion is that in the combustion chamber of large dimensions, ignition is slower than in the smaller sizes, therefore more unfavorable. He suggests as an improvement a double ignition, one on each side of the cylinder, or even multiple ignition so that combustion may take place as efficiently as in the smaller engines.

A possible cause of unsatisfactory results is due to the fact that proper care is not taken to proportion the parts to the speed and volume of the gases passing through them.

In the endeavor to build noiseless engines and to avoid the hammering of the valves too little lift is given to the latter and they open and close too slowly.

The more the size of gas engines is increased the more important it becomes to have all parts in proper proportion. The great size of the cylinder, and the insufficiency of valve inlet prevent the rapid filling of the combustion chamber and its capacity is therefore not fully utilized.

EDITORIAL COMMENT

Each month the Engineering Index brings its indications of the current work of the scientific world as reflected in the papers contributed to the technical societies and in the engineering press, showing not only the influence of passing events but also the lines along which future work may be expected. A new idea appears, sometimes merely as a suggestion in a discussion, or in the form of a note to a learned body. In a few weeks some one else takes it up; then comes a popular article, and before long what was only an interesting fact becomes a commercial possibility, developing into a great industrial factor. An excellent example is found in the progress of the liquefaction of air. It is but a short time since a few drops, hardly more than a deposit of dew on the walls of a glass bulb, were exhibited in a lecture room as a rare curiosity; then came a beakerful on the table of a popular lecturer, followed by larger quantities, available for experimental purposes and original research, and now we have the announcement among the articles of the month of the completion of a commercial plant to supply thousands of gallons per day.

* * *

The story of liquid air is but a repetition of that of aluminum. Once a rarity in the chemical museum, then a commercial material at many dollars a pound, ranging almost with the precious metals, and all at once brought by the methods of practical electro-chemistry into the market as a commercial product with innumerable applications in the arts. There is something curious in the fact that the metal which applied electricity made possible in the markets is likely to become a rival of copper as an electrical conductor, and thus we find electricity supplying the materials for its own utilization.

In this connection it is interesting to notice the discussion in connection with the use of aluminum for military utensils, based on the experience of the French troops in Madagascar. The matter is re-

viewed at length elsewhere, but the necessity of using the purest metal possible for such purposes is undoubtedly demonstrated.

* * *

The question of internal waterways in Germany, already alluded to before in these columns, forms an important feature in some of the continental papers of the month, largely because of the political character which has become attached to the Rhine-Elbe Canal project. That the canal will ultimately be constructed in some form is more than probable, although the present indications are that a strong opposition to the plans of the government has succeeded in delaying the matter for the present. From an engineering standpoint the plans as urged by the government seem both feasible and desirable, but political and engineering considerations do not always harmonize, either in English or German speaking countries.

Another question which is attracting interest on the continent, and in which both engineering and politics are involved, is that of the government control of water-power rights. In Austria, Italy, and even Switzerland, the activity in the development in water-power, consequent on a realisation of the possibilities of electrical transmission, has caused the government authorities to see that there is opportunity for an increase in national power, and possibly in national revenue; but the methods of handling such a delicate problem cause the engineer to prefer to leave this subject to those accustomed to more diplomatic methods than those in which he has been trained.

* * *

Meanwhile the development and application of natural sources of power goes merrily on, and from all parts of the world come accounts of plans for new hydraulic and electric power plants.

Where water-power is not available the later idea of the utilisation of waste gases in gas motors continues to find favor, and

in this connection the latest plan is to utilise in like manner the far richer gases which are now being discharged and wasted from many coke ovens on both sides of the Atlantic. Even where by-product coke ovens are used the gases possess a high calorific value after the volatile products have been removed, and indeed in every kind of furnace it appears that there is much valuable fuel now being wasted in the form of gas which might be recovered to advantage. The whole subject of gas engineering continues to attract much attention, judging from the number of papers appearing in the journals of the month upon this and allied subjects. So far from having been injured by the competition which electricity has produced, there is no doubt that it has been immensely stimulated, and if it were possible to go back to that state of darkness which people once thought was light, before the days when gas was prodded by electricity into something like real activity, great would be the wonderment as to how such a state of affairs could possibly have been endured.

* * *

The manner in which various engineering matters are inter-related is well shown in the question of municipal water supply. Two questions are presenting themselves simultaneously before the engineers of many great cities—one, the demand for purer and better water supply, the other, a growing disposition on the part of the users to waste the water in a most reckless and unnecessary manner.

Although these are apparently independent questions, yet it is found in nearly every case that the only method of obtaining a pure supply is to introduce filtration, and that the only way to make filtration possible is to limit the supply within reasonable bounds in order that the cost may not be prohibitory. Several papers this month relate to both branches of this important subject, and the end is not yet, as many facts clearly indicate.

Closely allied to this is the ever present matter of sewage disposal, this time in a special phase of its many sided nature. In nearly every city there is much trouble over the disposal of the wastes from manufacturing establishments, and, being large taxpayers, such establishments de-

mand the rights of the city sewers for outlets. So long as the wastes are not injurious to the sewers or public health this is all right, but it is found that much dangerous matter may be thus delivered, and that in many cases the temperature of the discharges is so high as to cause rapid decomposition of the organic contents of the sewers, to say nothing of the damage done to the sewers themselves by reason of the sudden changes of temperature. Clearly it is within reason to require that injurious wastes should be rendered innocuous, and that hot liquids should be cooled below a safe maximum temperature before delivery into the sewer system which serves an entire city.

* * *

In the realm of electricity space telegraphy continues to be the object of interest. The first stage of wonder and surprise having been succeeded by the usual one of "I told you so," is now being followed by the general attack all along the line to produce improvements which shall make every detail altogether practical and successful in daily work. It is the story of the telephone over again, and there is little doubt that before long this nine days' wonder will have become a matter of such every-day service as to be quite superseded in the popular eye by the next novelty. The Wehnelt interrupter has not yet passed the earlier stage of lecture room and laboratory experiment, probably because of the fact that it possesses less immediate practical utility; but many papers show the active interest which it still excites, and practical results will doubtless soon follow.

It has indeed been a busy month for the engineer, and he has done good work therein—work which not only makes a good showing for the present but is full of promise for the future.

* * *

Two points are practically noticeable in the manifold comment called out by the recent successes of American firms in getting contracts for engineering work in Great Britain and the colonies. The first—curious rather than practical—is the eagerness of the "man of one idea" to make every fact uphold his philosophy. Thus, one reformer finds the solution of the whole

matter in the American patent system—but his argument is weakened by his entire mistake as to what that system is; another, with a deplorably low opinion of the British workman, sees the British industrial structure tottering to its ruin, undermined by the flood of strong drink; a third attributes the inroads of American industry to the better education of the American mechanic, and to borrow a phrase from the children's game, he is "growing warmer." Social and economic conditions lie closer to the root of the matter than is usually admitted by engineers. But it is a tribute to the general breadth of economic view in Britain that hardly anyone—except an occasional maker of a rejected tender—has suggested the artificial "protection" of shutting out the foreign competitor.

And this brings us to the second point, immensely practical and significant; that is, the alert and widespread attention centered upon even the smallest inroad of the outside competitor into the "sphere of influence" of the English engineering trades—the determination to sift the causes to the last grain, and the frank readiness to face the conclusion, honestly and without disguise, and to grapple boldly with the situation, whatever it may be, and, drowning the pipings of the little philosophers, there is rising the deep, steady, consonant chorus of the true prophets proclaiming the real cause. It is well voiced by the writer of a clever review column in a London daily. Commenting upon the current articles in *THE ENGINEERING MAGAZINE* by Mr. Orcutt—a prophet in the fullest sense, since he wrote before the event—the reviewer says:

"But we believe that the true and correct reply is that of Mr. Orcutt in *THE ENGINEERING MAGAZINE*. He ascribes the British defeat to two great causes; the intense conservatism of mind which marks the British manufacturer and the want of originality in the British working-man.

"The British manufacturer will not adopt the latest and best machinery. He buys a particular type of machine because he and his fathers before him have always bought it. He does not ask if other machines are better suited to his work. He is conservative, and the British maker of

machines, whose energy is not being constantly stimulated, also grows conservative. The consequences we see in such a fact as the erection of a huge gun-lathe, made, not in England, but in America, by the go-ahead Vickers works in Sheffield. Time was when England built gun-lathes for the world. And now we cannot make them for ourselves!"

But there is in this no note of pessimism. England has been adapting herself to her environment for a thousand years. We may conclude, with the reviewer that: "the nation which governs India and which has regenerated Egypt need have no fears if it will only gird up its loins and realise the facts with which it is face to face. But sleep no more in slothful over-trust is our entreaty, addressed both to our manufacturers and to our working-men."

* * *

Mr. Barnes, Secretary of the Amalgamated Society of Engineers, has issued a circular devoted, in part, to showing that some of the much-discussed American orders—especially those for locomotives, were, after all, relatively inconsiderable. Citing Board of Trade returns, he shows that British exports of locomotives, and of all engineering products, are increasing annually at a very handsome rate and that the corresponding figures from American official statistics look small in comparison.

We may grant all this, and more. We may admit, as everyone must, that British engineering firms, almost without exception, have orders booked for months—sometimes for years—ahead; that many of them, far from seeking more business, are almost seeking escape from the press of work crowding upon them; that consulting engineers (to quote a distinguished correspondent) are regretting "that the day has only 24 hours and not 36." We may admit all this, and still miss the point.

The question is, not "are British engineering works taxed by the present volume of work," but "are British engineering works employed to the full of their possible capacity?" If they are, then surely it is time to build greater; if *not* (and this, we believe, must be the honest answer) if arrangement, or re-equipment, or re-organisation will increase their output—then the

change necessary for greater capacity must be made, or the main current of orders will break away from the old channel and follow the course of the present overflow. Mr. J. Slater Lewis has now in preparation for THE ENGINEERING MAGAZINE a series of papers upon "Works Organisations for the Maximum of Production" which will be most valuable at this juncture.

For the American contracts have been characterised not only by the quicker delivery promised, suggesting greater immediate capacity in the works securing them, but by far lower prices, indicating still larger differences in manufacturing economy. Some of these differences, as they

appear in locomotive building, are pointed out by Mr. Rous-Marten in this number. An extension of similar principles of "standardisation", to even larger engineering construction will be discussed in future issues by one of the foremost British engineers.

Granting everything ever claimed for American steel-making, it could account for a fraction only of the difference; it is in labour-costs and in constructive practice that the American competitor wins over his British rival. Unless he can be met on these grounds, sentiment will not long dominate home orders, and the decline of demand for British engineering products in export markets will be still speedier.

REVIEW OF THE BRITISH PRESS

Wind Pressure on Buildings.

THERE has been more or less discussion of late as to the proper allowance to be made for the force of the wind in proportioning buildings and other structures, and although there have been numerous cases of overturning and wrecking from the force of the wind it has been strongly maintained that the usual allowance is more than sufficient. Probably no structures offer a better mark for the wind than do gas holders, and the great bulk of such structures, together with the impossibility of securing them firmly to foundations, renders the estimate of wind-pressure a matter of especial importance to engineers engaged in connection with such work. A very full and valuable discussion of this subject was contributed by Mr. J. O. V. Irminger at the recent meeting of the Institution of Gas Engineers and his treatment was so full and broad as to be of interest to structural engineers in all lines of work.

After referring to the experimental investigations of Professors Langley, in America, and Kernot, in Australia, as well as of Herr Vogt, of Copenhagen, Mr. Irminger describes some very interesting experiments of his own, in which models of various forms were exposed to the draught produced by a chimney 100 feet high, careful measurements being made of the pressures and suction on all sides. The results of these tests are tabulated in connection with the computed values, using the formulas of previous experimenters, and fairly consistent figures are obtained.

The influence of the sucking action of the wind is especially important, acting as it does to modify very materially the direction of the resultant for which provision must be made in the construction, and the lifting effect upon roofs and gasholders should always be taken into account.

Referring to the statement of Sir J. Wolfe Barry concerning the excessive magnitude of the Board of Trade allowance of 56 pounds per square foot for wind-pressure, in connection with the Tower bridge,

Mr. Irminger shows that this suction effect has much to do with the diminishing of the direct pressure of the wind, and cites an instance of the measured pressure on a large gasholder in a storm as being only 4.9 pounds per square foot.

That such measurements should not lead engineers to err on the side of too small allowances for wind pressures, Mr. Irminger gives an abstract of the computations of Mr. J. Baier, upon the wind pressures which must have existed during the storm at St. Louis, U. S. A., in the summer of 1896. The damage done by that great storm is well known, and by computing the strength of some of the structures which were overthrown the actual force of the wind was determined. Mr. Irminger states that the velocity of the wind on that occasion was about double that known in Europe, and hence of four times the force, ranging from 40 to 60 pounds per square foot.

"Such a hurricane simply rases all and everything in its path but is fortunately not known in Europe; and, if we assume the forces mentioned by Mr. Baier are correct, it cannot be wondered at that the forces estimated in Europe are considerably less violent."

Mr. Baier's conclusions agree with those deduced from Mr. Irminger's experiments, and show that the wind acts in a direction quite different from that generally assumed and usually provided for in designing bridges, roofs, and buildings. "One may thus assume that the experiments on the small models have been verified by nature itself, and that calculations of the wind's force must be made on a different basis than hitherto, inasmuch as, besides the horizontal effects, the upward force must be taken into consideration, the power of which can equal half the wind's normal pressure."

The discussion of the paper bore out the idea that until now wind pressures have been studied with rather preconceived ideas. The construction of buildings has

proceeded in accordance with these ideas, and except when great catastrophes have called the attention of engineers to the failure of structures, very little seems to have been done in the way of investigation to see whether the established ideas are correct or not.

The increasing size and altitude of framed structures is rendering the question of proper allowance for wind-pressure a most important matter, and the experiments made by Mr. Irminger, as well as those of others cited by him, form valuable contributions to the subject. When such buildings are being designed it appears desirable that small models be made and tested in the simple manner described, and there is little doubt that the stability of the structure during wind storms would be materially increased if such information is obtained and used in the preliminary stages of the design.

Petroleum Motor-Vehicles.

THE development of automobile vehicles has been retarded in England because of the onerous restrictions which were placed upon them until three years ago, but since then England has made rapid progress in all kinds of motor vehicles.

An excellent historical and descriptive review of the progress which has been made in one branch of motor-vehicle construction is given in a very full paper upon petroleum motor vehicles, read before the Society of Engineers by Mr. James D. Roots, himself conspicuously identified with the development of successful vehicles of this class, and therefore especially well qualified to speak on the subject.

Petroleum vehicles undoubtedly owe their practical existence to the persistent labours of Daimler, who indeed may also be considered the one who made petroleum motors for all purposes possible in a practical sense. Daimler's first vehicle patent was taken out in 1885, and was a very crude affair, being constructed like the old bone-shaker with a petroleum motor placed between the two wheels, with two small trailing rollers, one on each side, to prevent the bicycle from falling over when not in motion. The general arrangement, so far as the propelling machinery is concerned, was not unlike that of the Daimler motor of

the present day, except that it had but a single cylinder. The petroleum was passed through a carburetter, and the tube igniter was used, and crude as the machine was, it contained the elements of practical success.

Daimler was followed by the patent of Benz, in Germany, and by Butler in England, and had been preceded in England by Hardaker, who patented in 1880 a motor vehicle operated by an internal combustion motor using gas compressed in a storage tank, but there is no evidence that this machine was ever built, and as it was designed to be used with compressed gas, it cannot be considered an anticipation of the modern petroleum engine.

Butler's tricycle was an ingeniously designed vehicle, but the defects in construction, which were probably unavoidable at that period, caused it to fail of practical success.

All these early vehicles used petroleum spirit, the vapour being used to form a carburetted air, which was exploded either by an electric spark or by a hot tube in the cylinder. Up to 1892 no attempts appear upon the record of the use of petroleum oil instead of spirit, but after that date the development in petroleum oil engines was sufficiently far advanced to permit of the application to vehicles, and Mr. Roots himself built a successful motor tricycle driven by a petroleum oil motor.

Notwithstanding the difficulties which attended the use of petroleum oil motors and ease of operation of engines using benzoline, the former rapidly displaced the latter for stationary use, the danger attending the storage and use of the volatile fuel being a very great objection to its use. The motor used by Mr. Roots was one of the "impulse every revolution" class, with a compression pump formed of the front stroke of the piston, the rod passing out through a stuffing box as in a steam engine. The motor was placed vertically between the rear wheels of a Coventry tricycle, and the motion transmitted to the axle by reducing bevel gears, a friction clutch being used to enable the tricycle to be stopped without stopping the motor; also for use when coasting. The principal objection to this machine was the tendency of the motor to reverse, because the new charge would sometimes ignite directly after it had entered the cylinder and

during the compression, and the vehicle would promptly begin running backwards. As this undesirable feature could not be corrected, this motor was replaced by one operating on the de Rochas cycle.

Later petroleum vehicles have improved, both as to motive power and mechanical construction, as experience upon the road has been gained, and the bulk of Mr. Roots' very complete paper is devoted to illustrated descriptions of the more successful and better-known petroleum vehicles of the present day. In many respects petroleum is preferable to electrical accumulators, especially for road vehicles, where it is almost a necessity that independence of local electrical power stations be secured. Petroleum may be procured almost anywhere, and with simple, inconspicuous, and effective motors, such as are now available, the petroleum engine is certainly well adapted for this trying service.

The general influence of the motor vehicle upon roads and transport is well emphasised by Mr. Roots.

"Consider what the position of road locomotion would have been if, as we may fairly assume, the same number of engineers had devoted their time, thought, and energy to the improvement of the road locomotive as in each generation since 1830 have employed themselves in the furtherance, improvement, and development of locomotion by rail. The high, and in some cases prohibitive freight charges upon certain railways, would now be impossible. The transport of all goods would have been cheaper, thus lessening the cost of country produce and market-garden stuffs and other goods to a great extent, especially in the large cities. Cheapness of transport will naturally cheapen the cost of all the necessities of life; cheapness of transport by road would have cheapened freight by rail. Moreover, our roads would be better and wider, and would not be allowed to get into the bad condition we now find them in every autumn and winter, and it would be a finable offence on the part of any local authority to put down granite or stones on the roads without immediately rolling them in. It would be equally an offence to allow any road to get below a certain level of standard excellence. Travelling and inspecting surveyors would ere this have been

appointed by the local governing board in each county, and if any roads should be found by an inspector to be below a predetermined standard of excellence, the local authority in whose district they were should be summoned to answer the charge before the Quarter Sessions. Permitting a bad road should be made a punishable offence, and it will be made so in time.

English and American Bridge Design.

THE publication of the detailed plans of the Atbara bridge calls forth in an editorial in *The Engineer* some plain language concerning the different methods in vogue in such work in England and in the United States, and in view of the marked interest which this work has attracted the subject will bear emphasising here.

The important question in connection with the bridge was that of prompt erection without false works, and as all the tenders from English builders were of the riveted lattice type, for the erection of which false works are necessary, the contract went to America. The designs show that the accepted bridge is of the American pin girder type, which can be erected by travelling derricks carried first on a span erected on the shore, and then on the successive spans as completed over the river, no false works being required.

Commenting on this straightforward solution of the problem, *The Engineer* asks:

"Even at the risk of being considered ungracious or troublesome we cannot resist asking the question: Why a pin bridge was not suggested in the first instance to English builders? They could have carried out the work just as well as any American builder.

"There is no doubt that this is entirely true, although pin girder bridges do not generally find favor with English builders. In general bridges are designed in England by civil engineers, who are not in close touch with the bridge builders, with the result that there is material loss, both in time and in money, which might have been avoided.

"So far as the facts are known the Pen-coyd Iron Works were given an absolutely free hand. There was the river, there were the piers, there was the open country for them. The spans and loads were stated,

that was all. We have not the least doubt that the result will be quite satisfactory, and we venture to suggest that, the ice having been broken, it would be well that the same system were adopted in this country.

"The present day is one of specialisation, and it is very easy to see that a firm whose whole time is spent in making and erecting bridges is far more likely to turn out work cheaply and expeditiously than a civil engineer who has a thousand-and-one other things to attend to besides designing bridges. The builder and steel maker will work into each other's hands, and the maker will take very good care to suit his design to ruling conditions. In fact, if the engineer does more than specify the loads per square inch of material and the general features of the bridge, he should go a great deal further and put himself in intimate relation with the steel maker and the bridge builder. The finished structure is the work of three different men, or sets of men, and unless they work together there must be waste of time, energy and money.

"It has been said that bridges are built by the mile in the States and cut off by the yard as required. This is not strictly true, but it is true that a great deal of work is done ready cut-and-dried in the offices of the best firms, and that they are always in a position to submit designs for any bridge, carefully prepared to reduce the expenditure of time and money to a minimum. The case of the Atbara bridge will go far to drive home the knowledge of this fact. We trust that the lesson conveyed will do much to place the relations of the civil engineer, the steel maker and the bridge builder on a better footing than they have recently occupied."

Comparisons of Similar Structures.

It is often a matter of great convenience and importance to be able to construct experimental models on a reduced scale and determine matters of proportion by trial, but it is most necessary to know in such cases the true relation which the completed structure and the model bear to each other. A very thoughtful and valuable essay upon this subject was presented before the Institution of Engineers and

Shipbuilders in Scotland, by Professor Archibald Barr, and published in the *Transactions*, and while only a brief abstract of this important paper can be given here, some of the salient points can be mentioned.

No apology is offered for the fact that tests upon experimental models are often necessary, since, from the very nature of the case many mechanical problems must be indeterminate, and especially in designs which are wide departures from accepted forms it becomes almost a necessity to verify theoretical deductions by experiments such as are discussed by Professor Barr.

After showing the difference which exists in relative strength between large and small specimens of like materials, Professor Barr discusses the relations of similar figures and gives the laws, as enunciated by Professor James Thomson many years ago, showing the relations which exist between loads and stress in similar structures of various dimensions. This includes the very important subject of the shape of test pieces for structural materials, and the necessity of having test pieces of similar form is emphasised.

Some very interesting comparisons are made between animals of various sizes, and the case of the spider and the elephant is illustrated to show that a greatly increased quantity of material is required for a given increase in size if a corresponding strength is to be attained.

If the elephant were constructed on the proportions of the spider he would have crooked legs 80 to 90 feet long and about 6 inches in diameter. Various other examples from nature are given, all of which help to show the principles very clearly.

When structures are increased in size the relative importance of various conditions is altered. In railway bridges we have to consider the weight of the structure itself and also the weight of the heaviest load that may come upon the rails. When the structure is small its own weight is unimportant compared with the load which it is to carry, but with increase of span the weight of the structure becomes more and more important. In the case of suspension and cantilever bridges the greatest weight of structure per foot of

span occurs at the piers, where it produces least effect, whereas in simple girder bridges the weight is mostly concentrated at the centre of the span, where it produces the greatest effect. But even with this very favourable element in the design the Forth bridge had to be designed almost entirely to bear its own weight and the wind pressure. Had the bridge been designed as a monument or as an ornament, and not to carry any railway tracks, it would—assuming the same general outlines—have had to be almost as strong as it is for the same general security.

The question of the stability of structures must also be considered when using different sizes in comparison. Here the stability of the larger structure is greater in proportion than that of the smaller one, one obelisk of double the dimensions of another having also double the stability, and the case of the inferior stability of model yachts is given as an excellent example of the diminished stability of small structures.

A number of interesting diagrams are given to illustrate the points made in the discussion, and the rules are enunciated in such a clear and intelligible form as to make the paper one of the utmost value in a department of mechanics which has been too little studied heretofore.

Blast Furnace and Coke Oven Gases.

IN considering the utilisable heat and power which exists in the waste gases of blast furnaces, the much richer discharge gases from the coke ovens have hitherto been overlooked as possible sources of energy. This subject was brought out in a paper by Mr. Enrique Disdier, of Bilbao, at the recent meeting of the Iron and Steel Institute, and his views attracted material attention.

Every blast furnace uses coke as fuel, a ton of coke being required for every ton of iron produced. By placing the coke ovens in close proximity to the furnace it would be practicable to use the lean gas from the blast furnace to heat the coke ovens, and use the rich gas from the ovens for motive power. Since the gas from a coke oven possesses almost as high a calorific value as illuminating gas, the advantage of this method is evident, and all other things

being equal the plan would certainly be most efficient.

Taking comparative figures, a furnace producing 100 tons of pig iron daily should be able to provide 2,100 horse power if the waste gases were used directly in gas engines, but only about 600 horse power if the same gas were burned under boilers. The gases from coke ovens of a capacity of 100 tons per day are estimated to be capable of producing 547 horse power when used in gas engines, about 60 per cent. of the heat from the gases being required to heat the ovens.

If, however, the coke ovens were heated by the furnace gases, and the whole of the oven gases were used for driving the engines the increase in power over that obtained by burning the furnace gases under steam boilers would be 2,400 horse power, the value of coal saved being more than £12,000 per annum.

Mr. Disdier says:

"Far-reaching changes in blast furnace practice may be expected when coke ovens and blast furnaces are placed side by side, forming one complete plant, and working according to the method described above. Steam boilers, steam pipes, steam engines and gas producers will be dispensed with, and will be replaced by a gas main, through which coke oven gases will be distributed to furnaces and gas engines. A central station, with dynamos driven by gas engines, might also distribute electricity to electric motors scattered about the works to replace steam engines. Excellent gas engines, rated up to 250 horse power, and capable of being worked with coke-oven gas without modification of the ordinary form, have already been built, and their general adoption is only a matter of time."

While the plan for using blast furnace and coke-oven gases in conjunction, or rather, successively, in the manner indicated in Mr. Disdier's paper, possesses some advantages, it is doubtful whether it is sufficiently superior to the direct use of the blast furnace gases in the engines to be worth the additional complication involved. In another column the interest which appears in this matter in Germany is shown, and there appears to be little doubt that before long the united interests of furnace

managers and gas engine builders will bring forth some very practical results. The difficulties which have thus far been encountered are by no means insuperable, and there is every reason to believe that before many years have passed the escaping gases from blast furnaces and coke ovens will all be fully utilised and no longer regarded as wastes.

Mechanical Engineering and Ship Building.

IN his presidential address before the Institution of Mechanical Engineers, Sir William H. White, among other interesting points drew a strong picture of the close relation which modern shipbuilding bears to mechanical engineering, showing how entirely the modern vessel, whether for war or for merchant service, is the product of mechanical operations and mechanical skill. Says he: "Mechanical engineering has intimate relations with all other branches of engineering. With none has it been more closely associated than with shipbuilding in recent times, and upon none has its influence been greater or more beneficial. The growth of our shipbuilding industry and the marvellous development of our mercantile marine during the last forty years are matters of common knowledge. The causes which have contributed to this supremacy are not so well understood and the part which mechanical engineering has played is not generally appreciated."

After enumerating the statistics of the growth of British shipping during the period indicated, and dwelling upon the changes wrought by the substitution of iron for wood and steel for iron, Sir William shows the contrast between an old-time ship-yard and one fitted out with modern mechanical appliances.

"The contrast between former conditions and those now to be seen in a modern ship-yard is extreme. Machinery and labor-saving appliances abound and are essential and economical working. With ships of increased dimensions scantlings have become heavier, the sizes and weights of plates and bars have increased, special arrangements have to be made for transporting and handling materials, and the power of all classes of machinery has had to be increased proportionally. In a well-equip-

ped yard the most careful consideration is given to every step necessary in dealing with materials, from their delivery up to the time when they find their places in the structures of ships. The stacks of plates and bars are so situated that the materials can readily be lifted from the trucks on arrival, or out of the depot when required for use."

The general use of traveling cranes and gantries is a matter of note, and the increasing employment of hydraulic and pneumatic tools, both for stationary and portable service, is also important. It is in the combination of all the multitudinous variety of machines and tools that the great influence of the mechanical engineer upon modern shipbuilding is seen, and it is not only the work of the mechanical engineer but also that of the electrician which has been utilised to the utmost.

"Electric power is being extensively used in some of the best equipped shipyards, apparently with satisfactory results. It is probable that the system will be much more extensively employed before long. For large machines with separate motors, and for groups of smaller machines, electric driving has much to recommend it. For operations that have to be performed *in situ*, portable electric machines are found most useful. In some cases, especially in elaborately fitted warships, it is found advantageous to establish on board temporary machine shops, which can be most conveniently driven by electric power."

When it comes to the preparation of the material used by the shipbuilder, the influence of the mechanical engineer predominates still more. Modern shipbuilding could not exist without the great progress which has been made in the manufacture of structural material.

"The shipbuilder is under great obligations to the steel maker for this progress in manufacture; but the mechanical engineer has had a hand in its achievement by designing and making the plant used in the steel works. In the device of new and more powerful machines for the shipyard his work has been more obvious. Without such machines the superior working qualities of steel could not have been utilised as is now done. Operations are now commonly performed on steel plates in a cold state

that were not possible with the best qualities of iron."

In fact all the long list of shipyard tools, including flanging, joggling, shearing and punching machines, as well as bending rolls, plate planers and all the better known machine tools are contributions of the mechanical engineer to the work of the ship-builder.

On board the completed ship the work of the mechanical engineer is everywhere in evidence, from the propelling machinery, through the hoisting, lighting, ventilating and steering machinery, down to the smallest and pettiest applications of power. On warships especially is the work of the engineer conspicuous, so much so that the modern warship is not inappropriately called a "fighting machine."

Sir William White calls attention to the fact that the floating repair ship "Vulcan," of the United States Navy, was not the first of its kind, and that a "Vulcan," carrying a foundry, machine shop and forge shop, was equipped for the British Navy in 1887. Doubtless the floating machine shop will form an essential feature in modern navies of all nations hereafter.

British Coal Supplies.

THE probable duration of the coal supplies of Great Britain has formed the theme of many a discourse, and the latest and most important of these is the valuable paper of Mr. T. Forster Brown, read before the Society of Arts, and published in the journal of the society.

After noting the tremendous influence exercised by the increasing cost of coal upon the manufacturing interests of England, Mr. Brown calls attention to the main factors in the problem, which demand serious consideration. Briefly stated these are:

1. That while England has unworked coal resources capable of furnishing a supply for about 300 years, yet the best and cheapest of these will probably be exhausted in about fifty years, after which time the cost of working will rapidly increase.

2. That coal will be produced in the United States cheaply for a far longer period than England can, and that with the exhaustion of the cream of the English coal fields the question of the competition

of American coal will become a matter of serious import.

3. That the large coal fields of Russia and China, when further developed, will also become serious additional factors in the competition of the future.

Mr. Brown then gives an abstract of Professor Hull's estimate of the approximate quantity of workable coal which will remain at the close of the present century at a depth of 4,000 feet, this being the probable utmost limit at which workings will be practicable. Taking into account the various fields, the result is as follows:

The Midlands.....	35,000,000,000 tons
The Great Northern.....	6,000,000,000 "
The Northwestern.....	11,000,000,000 "
The Western.....	2,000,000,000 "
The Welsh.....	20,000,000,000 "
The Scotch.....	8,000,000,000 "
The Irish.....	155,000,000 "

This gives a total of about 82,000,000,000 tons of coal for the total available resources at the beginning of the century.

"Taking all the circumstances into consideration the author of the paper estimates that of the best and cheapest of the coal supplies of Great Britain there originally existed about 20,000,000,000 tons, existing at a less depth than 2,000 feet below the surface, and that there may be probably remaining at the end of 1899 about 15,000,000,000 tons of this quantity, the bulk of which, he estimates, will be exhausted by the middle of the next century.

"This leaves about 67,000,000,000 tons of coal still available, sufficient to supply 250,000,000 tons a year output for upwards of 250 years, but comprising coal of either inferior quality or best coal obtainable at a greater cost per ton than at present prevails, owing to physical disadvantages by reason of depth and so forth."

After showing the causes for the increasing cost of working coal, including the increased cost of labor, the increasing burden of rates and taxes, and of large colliery staffs and improvements, as well as the various requirements of the Coal Mines Regulations and Workmen's Compensation Acts, Mr. Brown proceeds to show that no great increase in cost need be expected for the next fifty years, but that after that time a steady increase in cost will follow.

In view of this fact he suggests that what-

ever remedial measures are adopted they ought to be so arranged that they will come into partial operation by the end of a half century, and be capable of adjustment so far as they can be utilised from decade to decade to counteract the increasing cost of working.

In examining the coal resources of other countries Mr. Brown gives data about the coal fields of America, Russia and China, in particular, placing the American competition as the one first to be expected, and indeed already felt in distant British markets. The principal element to be considered in connection with American coal is the distance of the various fields from the coast, and the reductions which have been made in the cost of the carriage of coal therefore form an important element in this competition.

The Russian coal fields, while at least three times the extent of those of Great Britain, and worked at a less cost, are not likely to enter into competition soon, owing to the distance from seaports and the cost of transport; but the much greater coal fields of China are now on the point of being more extensively developed. Some of these fields are near the sea-board, and furnish coals of good quality for navigation and manufacturing purposes, and will doubtless enter into the problem before many years.

In all these foreign fields the tendency is toward cheapening the production of

coal, while in Great Britain the reverse is the case.

The remedial measure suggested by the author is mainly in the direction of cheaper and better mineral transport, which, he thinks, would be obtained if the railways were in the hands of the State.

Under judicious State management he estimates that the income of the railways would be increased so that in thirty to forty years' time the increase in revenue would amount to £60,000,000 per annum.

This fund could then be used to lower the rates upon minerals in proportion to the increased cost of production. This method is to be supplemented by efforts to pay off the nation's indebtedness during the period when the cheapest and best coal resources yet remain, so that the reduction in rates thereafter may compensate for the increased cost of working. These and similar measures he believes to be worthy the serious consideration of politicians and the nation. If nothing is done the commercial supremacy of Great Britain will be seriously threatened, while if the capital value of the railways and other works were paid off in the fifty years, and the cost of travelling and the transit of minerals be reduced by one-half, the increased cost of coal, due to natural causes, would be practically neutralized, and the nation would be able to hold its own, so long, at all events, as the coal resources of the country endured.

REVIEW ^{OF} _{THE} CONTINENTAL PRESS

Power Required by Machine Tools.

IN determining the power consumed by machine tools when operating under various conditions it is customary to measure the power required when running empty and deduct this quantity from that used when performing work. That this method is not exactly correct has long been known, since it is evident that the friction of the machine itself cannot be the same in the two cases, but it has been assumed that the error from this cause was not great enough to be of material consequence.

In the course of a recent series of experiments to investigate the power consumed by metal-working tools, MM. Huillier and Fremont made an interesting calibration of the dynamometer used, in connection with various determinate degrees of resistance at the machine, and thus were enabled to take the increased friction of the tool into account. A very full report of these valuable trials upon a number of tools is given in the *Bulletin de la Société d'Encouragement pour l'Industrie Nationale*, the whole forming an important contribution to this branch of technical knowledge. The variations in frictional resistance were made by delivering the power of the tool, a lathe for example, through a recording dynamometer of the Morin type, while various resistances were opposed by means of a Prony brake acting upon a pulley on a mandrel turned by the lathe. If the frictional resistance of the lathe had remained constant, the differences between the brake and dynamometer readings should have continued uniform, while any variations between the two measurements indicated the variation in the resistance of the lathe. By plotting the results of a number of such tests it was demonstrated that the friction of the machine increased directly with the resistance, being, in the case of a large lathe tested, equal to 16 per cent. of the added resistance on the brake. This coefficient of 16 per cent. varied somewhat

according to conditions of lubrication, temperature, etc., and similar coefficients should be determined for different groups of machines before making extended tests.

In conducting their further trials upon the resistance of machine tools MM. Huillier and Fremont adopted the method of measuring by the dynamometer the amount of power delivered to the machine and taking the effective work from the pressure exerted at the cutting point of the tool. In order to measure the actual pressure at the tool an ingenious form of dog was devised, of which detailed illustrations are given in the original paper. In the usual method of working the dog is clamped firmly to the work to be revolved in the lathe, and is also engaged positively with the face-plate, the work being thus pushed around by the force applied to the plate. In these experiments, however, the dog is so arranged that it is pulled around instead of being pushed, and being connected to the work by a spring arm, the effort required to revolve the piece against the fixed resistance of the cut is measured by the deflection of the spring. An ingenious system of levers transmits the deflection of the spring, as it revolves, to a fixed recording card, and the leverage being known, the resistance of the tool at the cutting point is recorded continuously. When to this is added a simultaneous record of the speed of the surface upon which the cut is acting, all the data for the computation of the power exerted are determined. Another factor, which although not essential to the measurement of the power, is of interest in connection with machine design, is the direct pressure required behind the tool for a given depth of cut; this was determined by a special pressure device fixed upon the slide rest.

Before proceeding to the use of these devices they were carefully calibrated by the direct application of weights, and the proper factor determined, so that reliance might be placed upon the corrected readings, the deflections only being measured

and the corresponding pressures computed.

In the application of these devices some interesting observations were made. During a continuous cut, as in the turning of a shaft, for instance, the resistance was by no means uniform, varying in the case of a shaft 92 millimetres in diameter, from 270 to 337 kilogrammes. This variation may be attributed to two causes; the lack of homogeneity in the metal and the breaking of the turnings. The unequal hardness of the material was evident, and it was easy to observe that variations in pressure on the tool occurred periodically as certain portions of the shaft came under the tool; the breaking of the turning could also be seen to affect the record of resistance. Making allowance for these variations by taking the mean resistance for a continuous run, and weighing the quantity of metal removed in the form of chips and turnings, a very complete record of the performance of various tools was obtained and tabulated.

In the paper above referred to the effort was made to determine more especially the power required by the various machines, and hence the conditions of the cutting tools themselves was maintained as nearly constant as possible, but in subsequent researches it is intended to vary the cutting angles, depth of cut, and similar conditions, and thus make practical comparisons. The present paper contains data from twenty-one different machine tools, giving for each machine the following data: speed of belt, pull on belt, power delivered, speed at the cutting point, weight of chips produced per hour, and net amount of work required to produce one kilogramme of chips, the tools including a variety of lathes, milling machines, and drill presses.

The Calibration of Current Meters.

THE use of current meters of the "Woltmann Mill" type for measuring the flow of water in streams is very general, not only on the continent but in many parts of the world, and the reliability of such instruments is a matter of much importance, especially when the necessity of comparing observations made by various persons in many places is realized. The only way in which any general laws governing the flow

of water can be deduced is by a critical analysis of a vast number of observations, and too often it has been realized that the conditions under which most desirable experiments have been made, render the results untrustworthy.

These facts give importance to the discussion as to the proper method of calibrating and testing current meters, and in a recent paper in the *Oesterr. Monatschrift für den Oeffentlichen Baudienst*, Herr Ernst Lauda, engineer of the Austrian Hydrographic Bureau, gives a critical examination of the subject.

The usual method of calibrating such meters consists in passing them along a tank at a known rate of speed and comparing the readings with the actual speeds as measured. In most cases these trial tanks are similar, on a small scale, to those used for tests on models of vessels, the instrument to be tested being carried on a carriage supported upon rails on each side of the tank and propelled by electricity, the speed being recorded automatically.

The assumption has generally been made that a given speed of carriage corresponds practically to the same velocity of current in an open stream, and the equation obtained from a number of such tank trials is usually applied with confidence when the instrument is used on rivers and streams. Variations in the results which have been found to exist in the readings of such current meters have led to a doubt as to the influence of the proximity of the walls of the trial tank to the vanes of the meter, and it has been inferred that a more reliable calibration would be effected in an open body of water than in a comparatively narrow tank. The accuracy of measurement possible upon a tank, with its electrically propelled carriage, and automatic recording apparatus, however, caused it to be thought advisable to investigate the actual effect of various widths of channel, and to determine, if possible, the true sources of the observed variations.

For this purpose Herr Lauda caused the Vienna testing tank to be fitted with adjustable walls of wood, which could be set to various distances apart, and, in conjunction with a movable wooden bottom, enabled a number of determinate widths and depths of channel to be obtained. Two current

meters, of standard reputation, were then given thorough investigation, both for channels of various dimensions, and for different rates of speed, and the results tabulated. By the method of least squares the corresponding corrective equation was then deduced in each case and the results expressed in curves, thus enabling the influence of channel section and velocity to be seen very clearly.

The first result of these trials was the demonstration of what had already been suspected, namely, that there were other sources of error besides the size of the channel. Thus the elasticity of the rod, which extended down into the water and carried the meter, caused a greater or less degree of flexure, and altered the angle which the revolving vanes presented to the direction of motion; and, in fact, the coincidence of the axis of revolution of the vanes with the direction of motion was rarely found to be exact, and any variation in this respect appeared in the reading of the instrument. This flexure of the rod is especially to be considered in making current measurements at various depths, the greater length of rod necessary for the deeper immersions being an important factor. Errors due to the imperfections of the testing apparatus, such as irregularities in the rails, and in the wheels of the carriage, as well as the unavoidable defects of the recording and measuring apparatus, all enter into the general result, and make it difficult to be sure of the location and magnitude of any error. These points in some instances appeared to overbalance any injurious influence which was directly due to the proximity of the sides of the channel, and in general the effect was found to be far less important than has hitherto been supposed. In the case of the meters tested it was found that with vanes from six to ten inches in diameter, changes in the width of the channel were without appreciable influence when the tank was more than about 30 inches wide.

The whole paper is an excellent example of careful investigation and valuable practical research, and shows how a popular impression, even among scientific men, may be found to be unsupported by actual and reliable experiment, while at the same time unsuspected errors are revealed.

Tests of Portland Cement.

THERE is always a mass of valuable information regarding the properties of materials of construction to be found in the publications of the Royal Testing Laboratory at Charlottenburg, and a recent issue of the *Mittheilungen* is entirely devoted to exhaustive researches into the properties of ten selected Portland cements, not only with regard to their resistance to rupture, but also in respect to their physical properties.

The tests which are recorded in the transactions were made conjointly by a committee of the professors at Charlottenburg and a commission representing the German manufacturers of Portland cement, the whole being under the general supervision of Professor Martens and the report being prepared by Professor Max Gary.

Before entering upon the detailed tests the preliminary portion of the report cites the general requirements which have been enunciated by the association of German cement manufacturers, and shows the value and importance to the consumer of the use of cement meeting those requirements. Apart from tests of strength these requirements include physical properties which have shown themselves to be of much importance. Thus if two briquettes are permitted to harden for 27 days, the one in cold water and the other in water maintained at a temperature of 90° C. (194° F.), and both appear hard as stone, free from cracks, and in the original form, the consumer may feel well assured that such a cement will be entirely satisfactory in practice so far as volume and solidity are concerned. If a more rapid test is required, a briquette which has remained for 24 hours in the air, and is then immersed for 2 hours in cold water and 24 hours in water heated to 90° C., should still be in its normal volume and condition.

To be classed as a slow-setting cement, a sample should remain for two hours after having been mixed to a mortar of normal consistency at the normal temperature, without showing any evidence of the beginning of any binding or setting. It is not always right to look with suspicion upon a slow-setting cement if it shows a marked rise in temperature during setting, for there are many excellent slow-setting cements in

which the binding process does not begin for six or seven hours after mixing, and in which, one hour after will show a rise in temperature of 5° to 7° C. Such cements are often better than those in which the setting begins in one-half to one hour, and is fully completed in seven hours, without showing any rise in temperature.

The quality of a Portland cement cannot justly be determined by a tension test made after 28 days' hardening in cold water, as a better idea of it can be obtained from a compression test, the best method being to make successive tests after hardening under cold water for 7, 14 and 28 days.

The full report includes information about ten standard German Portland cements, subjected to very careful detailed tests in accordance with the above general requirements, as well as many other modified tests, and extending over a period of more than three years, and the fully tabulated matter, together with the photographs of the test briquettes in various conditions, enables a very clear idea of the importance of the work to be obtained.

It is impracticable, in the limits of space here available to discuss the tests at length, and the report itself should be examined in detail by those interested in this branch of work. The general conclusion is that rapid tests are not reliable so far as the study of the physical properties of cements are concerned, and that reliable results are only obtainable from longer periods of time. The practical tests are those made by hardening the specimens in air and water under similar conditions to those which obtain in actual use. Under such conditions the standard cements tested gave results which were excellent, and the methods employed in the cases described are models for subsequent use.

The Chimneys of the Exposition Power-Plant.

SOME account was given in these columns last December of the plans which had been made for the concentration of the motive power of the Paris exposition, and a general description of the power-house was then reviewed. We now have accounts in *Le Génie Civil* of the construction work upon one of the great chimneys into which the batteries of boilers will deliver their discharge gases. At the exposition of 1889

there was no general united attempt to collect the power generating plant into a whole, and hence the boilers and engines formed a miscellaneous collection of machines, depending solely upon the individual exhibits for its effect. The great development of the power-house during the past ten years, due to a great extent to the central generation of electrical energy, has made it desirable that the exposition of 1900 should contain an example of such a plant, and it was therefore well decided that the power exhibits should be so arranged as to form a collective as well as an individual feature.

The buildings in which the power generating plant of the exposition is to be housed form the extremities of a portion of the space devoted to the electrical section, which is appropriate enough when it is remembered that three-fourths of the power generated by the engines is to be converted into electricity for lighting alone, and a large portion of the remaining fourth will also be transmitted electrically. The two power houses are identical in design and are on opposite sides of the Champ-de-Mars, there being a building 40 metres in width extending clear across the Champ-de-Mars, 117 metres of each end of this strip forming the area allotted for the boiler houses, one being on the Avenue de Suffren and the other on the Avenue de La Bourdonnais. The one facing on the Avenue de La Bourdonnais will be devoted entirely to the French exhibitors, and it is this one which is furthest advanced in construction.

In each of the great boiler houses the boilers discharge their gases into a central underground flue, which, increasing in dimensions as it proceeds, connects at the extremity of the space on which the house stands, with the great chimney, there being thus two chimneys to be constructed.

As it was desired that these chimneys should be ornamental as well as useful, a competition was opened for designs, and in the specifications laid down for the competitors the general dimensions were not only given, but it was stated that the ornamentation and construction should lend itself to the suitable illumination of the stack. This general lighting of all prominent objects being one of the features of the exposition.

The requirements were for a chimney 80

metres (262 feet) in height, with an internal diameter of 4.50 metres (14.75 feet) at top and 6.20 metres (20.35 feet) at bottom, and as the nature of the ground at the points of erection has been fairly well investigated during the construction of the machinery hall of the exposition of 1889, the design of the foundation could be laid out with a sufficient degree of certainty to make the preparation of plans a definite engineering problem.

A number of designs were submitted in the competition, most of them being architectural in conception, and including copies of Egyptian, gothic or renaissance columns, the one which was accepted being that of MM. Nicou and Demarigny, this being very fully illustrated in *Le Génie Civil*. This design has the merit of retaining the general appearance of a chimney, instead of attempting to make it appear as if it were something else, the decoration being employed merely to emphasize the constructional features. The ornamentation is confined to the upper and lower parts of the chimney, the shaft being left plain. At the bottom the buttresses which reinforce the stability of the base are brought out by effects in colored tiles, and an ornate pattern carried up above the moulding of the pedestal, while above the plain shaft a delicate pattern emphasizes the capital and serves to lighten the effect of the whole.

The work upon the foundation of this large chimney is well shown in the illustrations of the article referred to, the great circular pit having been carried to a depth of 8 metres, at which level the clay strata are encountered, and through which piles are being driven to the quartz sand 16 metres below. The diameter of the foundation is 18 metres (59 feet), and upon the heads of the piles a layer of concrete 5 feet thick is placed to receive the masonry of the base of the chimney. Upon this the superstructure is rising, the materials being hoisted up on the inside of the shaft, and no external scaffolding being required.

The chimney for the other boiler house will be of the same dimensions, but is to be designed entirely by engineers, no decoration being used except as the judgment of the mechanical taste of the constructors may indicate.

Power from Furnace Gases.

IN addition to the various communications to the technical press about the application of the discharge gases from blast furnaces in gas engines we now have in the *Zeitschrift des Vereines Deutscher Ingenieure*, a report by Professor Meyer, of Göttingen, upon tests made upon a 60 horse power engine at Differdingen, in Luxemburg, giving the latest and fullest information upon a subject of growing importance.

Herr Meyer first comments upon the general advantages of the gas engine, including the high thermal economy, the freedom from the inconvenience and danger accompanying boilers, and the absence of the labor of handling solid fuel; and he shows, by the use of the Rocour method of the heat-balance applied to the blast furnace, that only about 60 per cent. of the thermal value of the fuel used in a furnace is utilised in the operation of smelting. There remains, therefore, ample unburned fuel in the discharge gases, and this fuel can be utilised to double the advantage in gas engines than by burning under boilers.

The principal objections to the use of furnace gases in gas engines are given by Herr Meyer as follows:

1. Difficult and irregular ignition, low thermal efficiency, and the necessity of large cylinders, on account of the lean quality of the gases.
2. Fouling of the cylinders, excessive wear, due to the dust in the gas, and rapid deterioration of the lubricant, for the same reason.
3. Irregular speed of the engine, due to the unavoidable variation in the pressure of the gas as discharged from the furnace.
4. Difficulty of starting large gas engines.

These points are taken up seriatim by Herr Meyer, and it is shown that with improved methods of ignition, and especially with the use of higher compressions, that the ignition can be made as certain as with richer gas, and that with properly proportioned engines the efficiency can be kept at a high point.

So far as dust is concerned, it is a fact that dust creates almost as much trouble when the gas is burned under boilers as it could do in the cylinders of gas engines, while with reasonable provision for scrubbing the gas, the dust can be removed to an

extent which avoids all serious difficulty from this source.

The irregularities in pressure are readily met by delivering the gas into a holder, which rises and falls with the variations of delivery of gas, and permits a uniform delivery to the motors. The improvements which are constantly being made in the construction of large gas engines render the last objection of little moment, the only difference in respect of starting between engines for furnace gas and those for illuminating gas being the somewhat higher compression used in the former case.

The account of the test of the engine at Differdingen is of especial interest because of the very complete plans which are given of the arrangement of the plant. The scrubbers, pressure regulators, and connections for gas and air, are all well arranged and fully shown, and details of the minor modifications in the construction of the engine are also given. The 60 horse power engine was built by the Berlin-Anhalt Machine Works, and was of the usual four-cycle type, and drove a Schuckert continuous-current dynamo for the lighting of the iron works.

Tests of this engine with illuminating gas showed a capacity of 80 horse power, while with furnace gas the indicated power was 67 H. P., so that 16 per cent. less capacity was the result of the use of the leaner gas. The details of the test are given at length in the original paper, and only the results will here be enumerated; it will be seen that they are remarkably good, considering the conditions. Comparing the indicated power with the brake power, it appears that the mechanical efficiency of the machine was as high as 83 per cent., while the total efficiency of the combined engine and dynamo was about 70 per cent. The calorific value of the gas was determined by Junker's method, except that measurement on the gas holder was substituted for the less accurate method of the small meter generally used with the Junker calorimeter. The average thermal value of the gas was 940 calories per cubic metre (105.6 B. T. U. per cubic foot), and the average consumption per horse-power-hour was 2.32 cubic metres (82 cubic feet), and the thermal efficiency of the engine ranged between 27.4 to 30.2 per cent., the lower fig-

ure being when the indicated capacity was 46 H. P., and the best efficiency being when developing 79.5 H. P.

Such results as these show that there is no question about the high possible thermal efficiency of engines using furnace gases. Indeed, the performance of this engine is remarkable for any kind of gas, and the whole trial goes to show that the gas engine has already attained a position where it must be reckoned with on all sides as the coming motor.

The details of Herr Meyer's trials form a most excellent study for use in connection with gas engine tests, and form a valuable guide to those undertaking similar trials elsewhere.

Hot Water in Sewers.

THE too common practice of delivering the hot waste water from manufacturing establishments into city sewers is commented on in a recent issue of the *Gesundheits-Ingenieur*, and a number of points in connection with the effects of the practice are brought out.

The question arose in Germany in connection with the completion of the new sewerage system of the city of Magdeburg, in which the sewerage is delivered into one general collector, from which it is drawn by the pumping machinery for distribution over the area used as a sewage farm. The discharge of hot wastes from factories had been permitted in the old sewers, and the question of the effects of this practice was referred to a medical commission before formulating regulations in regard to the new system.

As it was not desired to forbid the use of the sewers to any establishment the question referred to in the commission was the determination of the maximum degree of temperature which could be permitted in waste discharges without danger to public health, and without material injury to the sewer itself.

With regard to the injury to the sewer, this is caused mainly by the unequal expansion and contraction due to the sudden entrance of hot water, followed by cold, cracks being developed which rapidly widen and weaken the whole structure, besides permitting the seepage of the contents of the sewer into the surrounding soil. A moderate vol-

ume of warm water will also cause the disengagement of foul gases from the matter already in the sewer, besides producing vapor of water to such a degree as to make work in any part of the system impossible. Since modern sewers are usually so built that access may be had to nearly every portion for cleaning and repair this latter becomes an important feature, and it is clearly shown that water of a temperature of about 25° C. (77° F.), will give off enough vapor to cause the clothing of workmen to become uncomfortably wet in a short time.

So far as questions of hygiene are concerned, there is no doubt that the temperature of the sewage should be kept as low as is practicable. In some instances the regulations forbid the discharge of any matter into the sewers which is higher in temperature than that of the contents. When the hot water is pure water of condensation from steam engines it is better to allow it to flow directly into the river rather than into the sewer. It is generally agreed that the action of hot discharges, tending as they do to hasten decomposition of the organic matter in the sewage, is most injurious to public health, and on this account, if on no other, the temperature should be limited to a safe maximum.

Under these circumstances the commission reported that the highest temperature permissible for waste water discharged into the Magdeburg sewers should be 40° C. (104° F.), and if possible this should not be reached.

Apart from the injurious effect of discharge of hot wastes into sewers, the very fact that quantities of heated water are allowed to run away, indicates defective technical arrangements in the factories where this occurs. In nearly every case the heat thus thrown away could be utilized, and instead of being regarded as a loss, it should be considered as a product, and the refuse delivered to the sewer ought to have the heat contained in it absorbed in some profitable direction, without requiring the compulsion of a municipal ordinance.

Superheated Steam.

It is beginning to be generally admitted that superheating is about the best method available for reducing the losses due to cylinder condensation, and the principal dif-

ferences of opinion are those about the best method of producing and applying the superheated steam. Herr Hubert Hoff has described, in a recent issue of *Stahl und Eisen*, the latest practice in Germany in this line of steam practice, and his paper is well worth examining by those interested in this line of work.

Some of the older superheaters are shown, followed by illustrations of the superheaters of Schwörer, Hering, and Schmidt, and a number of methods of adapting these to boilers of different kinds are shown. The Schmidt engine, for especial use with superheated steam, is also illustrated, and the results of Professor Gutermuth, of Darmstadt, are quoted to show that a steam economy of 10 to 30 per cent. may be obtained with superheating, which is quite within practicable limits.

In this connection Herr Hoff calls attention to the effect of highly heated steam upon the strength of materials, noting that the tests of Rudeloff have proved that the strength of copper is diminished 50 per cent. for an increase in temperature from 16° to 293° C. Ordinary bronze diminishes still more rapidly in strength, but phosphor-bronze retains two-thirds of its strength at 15° C., when heated to 260° C. These facts should be borne in mind in designing pipes and connections to be used with superheated steam, and proper allowance made in determining proportions.

Aluminum for Household Utensils.

WHEN the modern electrical processes for producing aluminum were put into practical and commercial operation, it was expected that an important application of the metal would be for the construction of household utensils, especially for cooking, and in fact many such applications have been made. In France especially, camp utensils of aluminum have been supplied to many regiments in the army, the light weight and supposed freedom from corrosion making the metal far more desirable than tin-plate for this purpose.

In a recent communication to the French Academy M. A. Ditte discussed the objections to aluminum for this purpose, his remarks being very largely based upon the condition in which many of the utensils were found after the return of the troops

from the Madagascar campaign. According to M. Ditte, aluminum is readily attacked by acetic acid in the form of vinegar, and is also acted upon by salt water, and even the portable water-tanks of aluminum used in Madagascar were found to be pitted with holes, showing apparently the action of ordinary drinking water. The insides of cooking vessels were also said to be covered with a greasy coating, and altogether a bad case was made out against the metal.

A very exhaustive response has been made to this paper by a communication to the Academy by M. Moissan, who is certainly well adapted to speak from experience as to the properties of aluminum, and he shows that while many of the facts cited by M. Ditte are true, the conclusions drawn from them are incorrect.

In the first place it is well known that the presence of impurities in the metal greatly decrease its capacity to resist corrosion, and most if not all of the articles served out to the soldiers who went to Madagascar were made from the earlier products of the aluminum works, when the metal was by no means so free from impurities as it now can be had. M. Moissan shows by comparative analyses that commercial samples of aluminum of 1893 contained only about 92 to 93 per cent. of pure metal, there being 5 to 6 per cent. of copper, and usually more than 1 per cent. of iron, while commercial specimens of 1897 contained 97 to 99 per cent. of aluminum, and usually less than 2 per cent. of copper,

the iron being below 0.2 per cent., and the silicon below 0.1 per cent.

M. Moissan also calls attention to the important fact that aluminum readily forms an electrolytic couple with almost any other metal, and that especially with iron a corrosive action is readily set up. This fully accounts for the behavior of the metal of the water carts, in which the aluminum tanks were carried in iron frames, and in which therefore the corrosion was undoubtedly due to the electrical action and not to the influence of the contents.

So far as actual experience goes, M. Moissan remarks that during the past three years the cooking in his own household has been entirely performed in utensils of aluminum, and that there has been no evidence whatever of corrosion or of the formation of any coating. These vessels have been heated over gas in summer, and over coals in winter, and have been subjected to the tender mercies of a succession of servants, receiving no especial care, and are yet in excellent condition.

M. Ditte, in a subsequent response, called attention to the fact that some of M. Moissan's points were not well taken, but on the whole the result of the discussion between these eminent experts before a most competent audience, is that with reasonable care, and the use of commercially pure aluminum free from contact with other metals, no danger or inconvenience need be apprehended in using aluminum for household or military utensils.

REVIEW OF THE AMERICAN PRESS

The Efficiency of the Bicycle.

THE active competition between various bicycle manufacturers has led many claims to be advanced as to the superior efficiency of this or that form, and many modifications have been made merely for the purpose of establishing so-called "talking points." Several systematic investigations have been made, however, by men not directly interested in any especial make, and some of the results of these investigations are very interesting.

A paper upon the efficiency of the bicycle, read before the Civil Engineers' Club of Cleveland, by R. H. Fernald, and published in the *Journal of the Association of Engineering Societies*, gives the results of a number of tests of machines under various conditions, and the data and results of these trials as there given form an interesting record.

The apparatus used was similar to that devised by Mr. Mack, and described in connection with previous trials in a paper presented before the American Society of Mechanical Engineers. This apparatus was intended to treat the bicycle, not under road conditions, but simply as a machine, this being at the same time the simplest and the fairest method, since the varying conditions of road trials render it practically impossible to obtain comparable results. The apparatus practically converts the bicycle into a hoisting machine, the hoisting being affected by applying weights to the pedal and causing the machine, as it advances, to lift a weight by drawing on a cord passing back and down over a pulley. An average load of 150 pounds was placed upon the saddle, and the track was formed of the smooth surface of the top of a beam, so that the external resistances were reduced to a minimum, and calibration of those remaining enabled proper correction to be made.

The results obtained were plotted as curves, the abscissas representing gross weights lifted, and the ordinates percentages of efficiency, the efficiency percentage

being obtained by dividing the product of the weight lifted into its distance by the weight applied to the pedal in its distance. Naturally one of the first tests discussed is that of the relative efficiencies of chainless and chain wheels. While it was found difficult to be sure that all other conditions were identical, yet with every care in this respect it appeared that the chainless wheel showed a somewhat higher efficiency for small loads, while for heavier loads the efficiencies were practically the same.

Another comparison of importance was that between different grades of the same make of bicycle. Here the difference was marked and consistent, the curves showing a steady divergence in favor of the higher grade wheel. A very marked difference also appeared between a regular wheel and a special racing bicycle of the same make, prepared for the use of a man riding for the makers.

When the medium and the cheap bicycles are compared very little difference appears between them, and indeed one result of these trials is the demonstration of the excellent efficiency of all the wheels tested. Even a \$25 bicycle showed an efficiency of about 92 per cent., while the difference between a dirty wheel and the same one cleaned is only about 90 to 96 per cent.

An interesting point was the marked improvement made in the efficiency of a good wheel after a moderate amount of use. Tests of a new machine showed many irregularities in the curve, showing that, although the wheel was of high grade, there were irregularities in the chain, sprockets, and bearings. After the same wheel had been ridden a few hundred miles it was again placed upon the testing machine, and showed a much smoother action as well as a higher efficiency curve, evidently due to the wearing down of the original imperfections. This is only what might have been expected, since the analogy of all other machines shows a "limbering up" with a moderate degree of careful use.

Theory indicates that easier running should be obtained with larger sprocket wheels, and this view is confirmed by the trials. The substitution of nine for eight teeth in the rear sprocket made but little difference in the efficiency, but the use of an eight-tooth rear sprocket gave an efficiency of 97.5 per cent. of that of the ten-tooth.

Tests upon tires showed greater variations than any others, differences in the inflation giving marked differences in the curves, the greater efficiency being naturally found with the strongest inflation.

While these tests were far from being complete they give much very useful information about this much-used machine, and the most gratifying thing about them is the generally good showing made by all the wheels, no one of them failing to reach 90 per cent. efficiency at full load, even under most unfavorable conditions.

A Great Electric Plant.

WHAT is undoubtedly the greatest isolated electric light plant in the world is that installed and in operation in the Waldorf-Astoria Hotel in New York, of which a very full description is given in *Power*, from which an abstract is here taken:

"If you were told of a steam plant with a boiler capacity of 4,000 horse power, with electric generators capable of developing 1,500 kilowatts, with 25,000 electric lights, with a refrigerating plant having a cooling capacity equal to the melting of 150 tons of ice per day, with pumps sufficient to handle the water supply for a city of 400,000 inhabitants, a plant which has 152 steam and 102 water cylinders, and 56 electric motors, and a force of 116 men in the engineers' department, would it occur to you that it was simply the mechanical plant of a hotel?"

It is a characteristic feature of all American hotels and business buildings that they contain machinery and power to an extent unknown in other parts of the world, and one of the features of an American city which impresses visiting foreigners is the evidence of power machinery in the tall chimneys and escaping steam from the tops of buildings devoted to residence and business purposes. The climax of this feature is undoubtedly reached in the Wal-

dorf-Astoria plant. A description of the plant would consist merely of an enumeration of a list of engines and machines, conveying rather an idea of the products of a great machine works than of the contents of the basement of a hotel, but some general idea of the character of the plant may be obtained from the following general description:

Steam is generated in seven Babcock and Wilcox boilers, aggregating 2,600 horsepower in the Astor Court plant, supplemented by 1,000 horse-power from the Waldorf plant when steam heating is required. These boilers supply six Allis engines, aggregating more than 1,800 horsepower, built on the rolling mill style and connected direct to four 250-kilowatt and two 100-kilowatt multipolar generators, forming the largest isolated installation in the world. The larger generators are guaranteed for 93¼ per cent. commercial efficiency at full load; 92½ per cent. at three-quarter load, and 91½ per cent. at half load, and the smaller machines are guaranteed at 1 per cent. less efficiency at each point. All the machines are guaranteed to carry full load without sparking, the maximum rise in temperature being 85° F. at the commutator, and 70° F. elsewhere. They were built by the Walker Manufacturing Company. A storage battery of 56 cells is used to equalize the load.

Numerous electric motors, ranging from 90 horse power down, are scattered all over the plant, motors even being used to drive the coffee mills, and all being direct connected. The elevators are driven by electricity, as are all the machines in the laundry, and the ease with which electric power can be obtained renders it available for every power purpose imaginable. Three 50-ton De La Vergne refrigerating machines are required for the cold storage plant, and a pumping plant like that of a great city waterworks completes the actual power portion of the equipment.

The ventilating plant is a noteworthy portion of the establishment, providing as it does for the movement of 14,000,000 cubic feet of air per hour through the four lower floors of the hotel, these being the rooms used for the restaurants, cafés, dining rooms, concert halls and ballrooms. Five Sturtevant blowers are employed for

this purpose, one of 12 feet diameter of wheel and four of 10 feet.

The whole plant contains a multitude of details impossible to enumerate, but necessary to make up the effective whole, and a visit to the power rooms is one of the sights of the hotel; an observation gallery being provided for the purpose of enabling the engine room to be visited and observed in a convenient manner.

Apart from the direct interest which this great plant excites in connection with the hotel itself, it is an important example of the manner in which engineering features are becoming a portion of the daily life of everyone. Formerly steam engines and boilers formed portions only of manufacturing establishments, and electric machinery was seen only in central stations and power houses. To-day power plants are in the basements of nearly all large buildings and many small ones, and one is not surprised to see steam issuing from the top of any building. Even where steam is not used the convenient gas engine is frequently installed, and the general rule of doing everything possible by power is everywhere observed.

Problems in Telephone Engineering.

THE very fact that the term "engineering" can be applied to telephone work is evidence of the extent to which the work of the engineer has spread over nearly every branch of industry, and it is under this very suggestive title that Mr. Theodore Spencer has contributed a most interesting paper to the *Proceedings* of the Engineers' Club of Philadelphia.

Mr. Spencer's paper deals very largely with the exchange system, and with the manner in which the "talking" and "signaling" systems are operated, including the use of advisory incandescent lamps, by means of which the operators are automatically informed of the completion of the connection, and of many other details of the work.

"The present telephone exchange consists of a number of central offices connected by trunk lines; each central office is equipped with multiple switchboards and with power plants for furnishing power to energize transmitters at subscribers' stations. Associated with this talking is the

automatic signaling system from subscribers' stations to central offices and between central offices, the signals being operated from the same power plant that is used to energize transmitters."

The extreme sensitiveness of the telephone receiver requires that special precautions be taken to avoid inductive disturbances. Mr. Spencer gives, as an example of the sensitiveness of the telephone, the statement that one foot-pound of energy applied to a telephone receiver with no loss in conversion would produce a continuous audible sound for over three thousand years! The very small amount of energy required, therefore renders high efficiency, as commonly understood, altogether unnecessary, and the term efficiency, as applied in telephone practice, merely refers to the completeness with which conversation can be carried on.

Mr. Spencer discusses the question of the possibility of conducting telephone communication between the United States and England, and shows that even if the electrical difficulties are overcome the difference in time would render the telephone efficiency very low. The records show that the great bulk of telephone messages are sent during that limited portion of the day known as "business hours." Owing to the five hours' difference in time between London and New York, the London business day is about two-thirds over when that in New York is just beginning, and the result is that telephone communication, even were it possible, would be practically limited to the few hours during which the business days overlap. The time relations between various places are analysed in connection with this idea, by means of graphical diagrams, and it is shown that, for commercial purposes at least, the telephone is best adapted for use within areas no greater than that of the United States.

"It is an old simile to compare a telephone line to a door. The comparison is a reasonably exact one: both permit the entrance of business and consequently of profits, to the telephone subscriber. Under present conditions a large part of the daily business of a city is transacted on the telephone. Would it be wise for a business man to restrict his trade by forcing all his visitors to pass through a single narrow

door that was constantly in use by persons passing in the opposite direction? And is it wise to insist that incoming orders and information shall be forced through one telephone line that is possibly already overcrowded with outgoing calls?"

The question of "particular person" service is one which is of importance in connection with telephone work. It is estimated that about 75 per cent. of the local business transmitted on the telephone is to any one at an office. At greater distances the business transmitted to particular individuals is almost 100 per cent. This is especially the case with the long distance telephone, conversation over which is generally unsatisfactory on important affairs unless there is a personal acquaintance between the persons talking.

"While it is always proper to criticise the shortcomings of any service, in criticising the service given by the telephone system the extraordinary usefulness and rapid development of the apparatus and plant must be considered. Aside from questions like the general ones of particular person service, improvement in this, as in other industrial undertakings, can only be reached by steady and patient development in the detail of apparatus and operating."

Compressed-Air Motors in New York.

NOTWITHSTANDING the success which has attended the use of the underground electric system in New York city for the propulsion of street cars, there are many instances where it is desirable to have a self-contained source of power, which can be operated on any existing road without the connection with any conductor, cable or other outside transmission. For this purpose compressed air is to be adopted, and from the *Street Railway Journal* we take some details of the system of the American Air Power Company as it is to be applied on certain cross-town railways.

As is the case with electric motors, the engines are to be contained in the trucks, a complete truck having a double cylinder air engine connected to each axle. The axles are straight, as in the case of ordinary electric motor cars, the engines connecting to pinion shafts geared about two to one to the truck axles, and the motors and gearing all being enclosed in a dust-

proof case containing oil. The use of side rods is dispensed with, each axle being driven independently, one by two high-pressure motors, the other by two low-pressure motors. The principle closely followed in the design is that of the general standard street railway practice as developed on electric roads, retaining the standard wheels, axles, trucks and car bodies, as it is believed that these have now reached a form in which the expense of maintenance is a minimum. Following also electric practice the controller is designed with two handles, one for speed and the other for direction, and it is easy for one familiar with the operation of an electric motor to control one operated by compressed air.

The compressed air is contained in seamless steel bottles, placed under the seats. These bottles are 21 feet 6 inches long and 9¼ inches in outside diameter, and have a factor of safety of three, the initial pressure being 2,400 pounds. From this pressure the air is reduced to 320 pounds per square inch, passing through a hot water heater on its way to the reducing valve. The water in the heater is at a temperature of 400° F., and a portion of water at this temperature is also injected into the air in order to supply moisture.

This degree of heating is intended to prevent the production of excessive cold in the exhaust, while the added moisture assists in packing the joints, dry air being difficult to manage in this respect, while the expansion of the moisture in the cylinders assists in maintaining the pressure towards the end of the stroke.

The controller operates both by varying the cut-off and by throttling, a compound handle being used, the cut-off being set at as early a point as will give the desired power, and the control then effected by the throttle, while for emergency power later cut-offs are available.

A powerful four-stage air compressor, of the Ingersoll-Sergeant make, has been constructed for use at the charging station, the capacity being 1,000 horse-power. The machine consists of a vertical cross-compound engine, built by E. P. Allis Company, with cylinders 32 and 68 inches diameter by 60 inches stroke, while the air compressor is placed directly beneath,

and has four cylinders, the low pressure being 46 inches, the first intermediate 24 inches, the second intermediate 14 inches, and the high pressure cylinder 6 inches diameter, the stroke of all being 60 inches. These cylinders are all single-acting and are water-jacketted, and inter-coolers are placed between them. The whole machine is 60 feet in height, from which some idea of the magnitude of the plant may be obtained.

The system differs in many respects from those used in Europe, notably in the form of motors employed, in the method of heating, and in the high pressure used. By the use of a pressure of 2,400 pounds it is planned to operate trips of fifteen miles with such a charge as can be contained in the flasks under the seats, and there is reserve capacity sufficient for an increase up to double this if necessary. The main charging reservoir consists of a large number of the same type of flasks as are used in the cars, but carried in a rack and piped to a manifold, from which the air from the compressor is switched to any bank of reservoirs desired. This reservoir system is piped to the charging room, where are also nozzles for charging the heaters with hot water, so that a car, when run into the charging room, can be connected up and charged with little delay.

The whole system seems to have been worked out very carefully, and although improvements will doubtless suggest themselves after a period of practical experience, there seems little doubt that this important and initial plant in New York will prove a mechanical and commercial success.

Municipal Water Meters.

THE utter recklessness with which many people allow water to be wasted has become so general that cities which profess to pay any regard to good management are compelled to take measures to prevent waste, and to throw the burden of excessive use of water where it belongs—upon the immediate users and not upon the community at large. As this is a matter which is attracting much attention in various places the experience of the city of Richmond, Va., discussed at the convention of the American Waterworks Associa-

tion, and published in the *Engineering Record*, is of much interest.

The popular opinion about water meters is that they place a premium upon filth and uncleanness, and that as soon as water is paid for by measure people will become penurious in its use. It is useless to tell people that this is not the case, but the experience of Richmond may be allowed to speak for itself.

Originally provided with a gravity supply, increasing population and demands caused this to be supplemented by an intermediate and a high-service supply, but the consumption per capita increased from 45 gallons per day in 1870 to 92 gallons in 1880, and to 168 gallons in 1890. Citizens living on the high points had no water on the second floors of their houses during the day, and the risk from fire for want of pressure was serious.

Estimates showed that \$270,000 would be necessary for the additional mains, but the chief engineer, Mr. Bolling, maintained that the true remedy was the checking of the waste by the introduction of meters. The usual opposition followed, but the urgency of the case prevailed, and in the spring of 1897 \$15,000 were appropriated for meters, which were promptly installed. By the end of the year the pressure at the high points had increased 40 per cent., and the result was the introduction of meters in the low district, where after a year the pressure was found to have been increased 100 per cent. All complaint for want of water had ceased, and the pressure was the same at those points which would have been obtained by expending \$270,000 and assuming an annual expense of \$17,000. Prior to placing the meters the water-power pumps were insufficient to keep up the supply, and it was often necessary to run the steam pump, which increased the cost of pumping \$2,500 per annum, while since the past eighteen months the steam pump has not been used at all. The total expenditure for meters was \$20,000, while the entire annual saving is \$19,500. The per capita daily consumption for 1898 was 99 gallons, a reduction of 41 per cent. from that of 1890, and the quantity of water used is 27 per cent. less now than in 1890.

This is a simple story, but it may carry an important lesson to many greater cities

which are wrestling with the problem of increasing wastefulness, overworked engines, insufficient reservoir capacity, and all the abuses which have grown up under the old system. Those who fear that idle bugbear, injury to public health, due to insufficient use of water, will find that it exists only in the imagination, while other dangers can be invited by a neglected water supply which are far more real and pressing.

Thus the fire risk may be reduced very greatly by the increased pressure and fuller supply which the restriction of waste makes possible. Again, in many cities the introduction of proper filtration and sedimentation systems is rendered prohibitive in cost by reason of the excessive amount of water to be treated, while the introduction of meters may render an ample and pure supply available within reasonable limits of cost. The introduction of the system of selling water by measurement may be slow, but it must come if waste is to be stopped and public health and safety insured.

The Structural Design of Buildings.

THE general change which has entered into the structural details of buildings with the use of steel frame construction has made the work of the engineer in building construction a far more important feature than formerly, and at the present time many buildings practically realize the old idea of the countryman; they are built first and then have "the architecture put on to them." A paper upon some features of the structural design of buildings, by Professor Wm. H. Burr, in the *Journal of the Franklin Institute*, deals with the engineer's side of the question.

Beginning with the question of foundations, Professor Burr showed that formerly the questions of depth and character of foundations were left almost entirely to the judgment of the building constructors, but that with the heavy loads now imposed by the modern skyscrapers all this has been changed. "The own weight of such buildings is sufficient to impose upon the foundations loads per square foot as high as it is safe to place on foundation supports designed and built under the most competent engineering supervision. Similarly the

supports of the superstructure of the building, including beams, girders and columns, must be designed so as to reach the highest engineering excellence attained in the structural practice of the civil engineer. The tall office buildings of the present day, commonly known as skyscrapers, are now carried on frameworks of steel which form a component part of the building itself. The great height to which these buildings rise make it imperative that wind loads should be considered in their design as well as those which act in a vertical direction. Concisely put, the structural design and the construction of a modern high building requires the application of the most advanced engineering principles, and neither superstructure nor foundation can be satisfactorily designed or constructed except under the best engineering supervision, from the main features to the smallest details."

After classifying foundations into the three classes represented by those resting directly upon the earth or sand, those resting upon groups of piles, and those carried down to bed rock by the pneumatic caisson, Professor Burr cites existing buildings which form good examples of the various methods, and shows how the skill of the engineer must enter into the judgment in selecting the best kind of foundation for any given instance.

Coming to the superstructure, the modern steel framing is described, and the points wherein it differs from other forms of structural work are brought out. In bridge and other out-door work open columns are generally used, in order that access may be had to all parts for painting. In building construction, however, the majority of the sections are closed, and it may be stated with confidence, according to Professor Burr, that when the metal work of building columns is well painted with three coats of paint, applied to thoroughly clean surfaces, and when these columns receive such protection as it is perfectly feasible to attain in modern building construction, the question of possible corrosion with the lapse of time is one of very subordinate importance.

The questions of correct column proportion are well-known and simple in application, but to this must be added judgment

in using such forms as will permit of the construction of efficient details, particularly where the beams and girders are attached to the columns. These points are all attainable within the limits of good structural practice and at reasonable prices. Continuity should be secured in the columns at all joints, and eccentric loading especially avoided. This can readily be done with steel columns, but it is impossible to prevent eccentric applications of loads with cast-iron columns, not only because of the form of connections employed, but also because of the irregular sections. Professor Burr objects to the use of cast-iron columns in any case, and shows that if the same degree of safety is to be secured the structural steel column will be the cheapest, as it is in all respects the best.

The importance of thorough bracing against the pressure of the wind is also emphasized, and its neglect in many instances commented on, which, in view of the discussion of the subject in Europe is a matter of peculiar interest at the present time.

A Commercial Liquid Air Plant.

Up to about two years ago air had been liquefied only in minute quantities in a few laboratories, at a cost which bore no relation whatever to the quantity or value of the product. To-day there is being erected in New York a plant for the commercial manufacture of liquid air, with a capacity of 1,500 gallons per day.

Details of this plant are given in a recent issue of *Engineering News*, the apparatus being that of the General Liquid Air and Refrigerating Company, and many illustrations render the construction and operation of the apparatus clear.

The plant is merely a steam power refrigerating plant, utilizing the expansion of compressed air to produce a low temperature, and causing this cold air to react upon itself until a temperature is reached so low that liquefaction occurs.

Two independent two-stage air compressors of the Ingersoll-Sergeant type are used with intercoolers between the cylinders, the two forming a four-stage compressing plant. After the air has thus been raised to a pressure of 1,200 pounds per square inch it is passed through a sepa-

rator to remove oil and moisture, after which it is delivered into a system of coils in a brine tank. A second system of coils is also contained in the same tank, and into these expanded air is conducted, the cold thus produced lowering the temperature of the high pressure air in the first system.

The cold compressed air then goes to the liquefier, which is a pair of tanks containing spiral coils through which the air passes. The coils are in a double series, and by means of a reducing valve the air is permitted to expand in one series to a pressure of about 300 pounds, and in so doing cools the air in the other set, and by a continuous repetition of this action the temperature is lowered until the critical point is reached, and the liquefied air drops into the collecting chamber beneath.

Judging from the behaviour of this apparatus, the action indicates the temperature is gradually being reduced towards some minimum, which, so far as present indications go, is remarkably near the hypothetical absolute zero. From the results which have been obtained during the testing of the compressors it may be expected that the air will be actually solidified.

In the same account a description is given of the reservoirs in which the liquefied air may be carried and transported with little loss. These reservoirs consist of 40 gallon tanks surrounded by outer tanks, the intermediate space being kept cold automatically by the escape of a small quantity of the liquid air from the inner vessel. The whole is packed in a wicker basket, the space between being filled with some non-conducting material, and the loss by warming is thus reduced to a minimum.

Although the practical uses of liquid air are as yet very limited, the fact that it is thought a good business proposition to construct a plant of this magnitude shows that there are possibilities of a commercial nature ahead. One application is that of using the power of volatilized liquid air to operate a cooling fan, the cold exhaust of the motor being delivered into the current produced by the fan, thus supplying cold fresh air during hot weather, and in hospitals and sick rooms especially this apparatus should be most effective. Many other applications have been given in Professor Thomson's paper in the May issue of

this magazine, and there is little doubt that there will be, for the present, at least, a demand for liquid air for experiments.

As the plant above described has not yet been operated except in a preliminary manner, data are lacking from which to determine the cost of the product, and upon this cost much will depend as to possible applications. There is little doubt that the cost will be regulated largely by the law of demand and supply, and that a sufficiently large demand will be brought within commercial limits.

Compressed Air to Save Ships.

THE uses of compressed air are many and important, but in a recent issue of the *American Machinist* Mr. Frank Richards offers yet another application. The wrecking of the steamship Paris on the coast of Cornwall and the difficulties encountered in attempting to save her while a number of her compartments forward are filled with water, lead Mr. Richards to suggest the applicability of compressed air.

"There is a means of expelling the water from the filled compartments so obvious, and so certainly effective that it seems unaccountable that some engineer has not suggested it before this. Close the hatches of the flooded compartments and drive the water out by forcing air in. It would not make the slightest difference how big the holes might be in the bottom, as the water would be expelled and kept out on the same principle as in the old-fashioned diving bell."

This suggestion carries with it a much larger and more important one, namely, the use of air pumps instead of water pumps to save a leaking ship while afloat. As Mr. Richards well remarks, the work of trying to pump out a leaky ship is not only enormously wasted while it is going on, but it is never finished. If, however, the water leaking into a compartment of a ship be expelled by pumping air into the space, the work is done so soon as the compartment is filled with air down to the level of the leak. After that point is reached the ship is safe, no matter how large the hole, and no further pumping is necessary.

"Obviously the lesson which the incident of the hour should enforce is that the air compressor should be employed, not merely for the present emergency, but universally in ships as a cheaper and vastly more efficient protection. The use of compressed air for water expulsion should be provided for in the construction of the ship, especially in the staying of the decks and bulkheads, and in the construction of an occasional air lock instead of single doors or hatches. No elaborate system of piping would be required, as air hose would be preferable, and could be carried wherever wanted. The compressors would cost no more than the pumps which they would supplant. In the navy, where the employment of compressed air for auxiliary power transmission is still debated, this one use of air should be an overwhelming argument for its installation."

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-g*, semi-quarterly, *etc.* Other abbreviations used in the Index are: Ill=Illustrated; W=Words; Anon=Anonymous.

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|---|---|
| American Architect. <i>w</i> . Boston, U. S. A. | California Architect. <i>m</i> . San Francisco. |
| American Electrician. <i>m</i> . New York. | Canadian Architect. <i>m</i> . Toronto. |
| Am. Engineer and Railroad Journal. <i>m</i> . New York. | Canadian Electrical News. <i>m</i> . Toronto. |
| American Gas Light Journal. <i>w</i> . New York. | Canadian Engineer. <i>m</i> . Montreal. |
| American Geologist. <i>m</i> . Minneapolis, U. S. A. | Canadian Mining Review. <i>m</i> . Ottawa. |
| American Journal of Science. <i>m</i> . New Haven, Conn. | Chem. Met. Soc. of S. Africa. <i>m</i> . Johannesburg. |
| American Machinist. <i>w</i> . New York. | Colliery Guardian. <i>w</i> . London. |
| Am. Manufacturer and Iron World. <i>w</i> . Pittsburg. | Compressed Air. <i>m</i> . New York. |
| American Shipbuilder. <i>w</i> . New York. | Comptes Rendus de l'Acad. des Sciences. <i>w</i> . Paris. |
| Am. Soc. of Irrigation Engineers. <i>qr</i> . Denver | Consular Reports. <i>m</i> . Washington. |
| Annales des Ponts et Chaussées. <i>m</i> . Paris. | Contemporary Review. <i>m</i> . London. |
| Architect. <i>w</i> . London. | Deutsche Bauzeitung. <i>b-w</i> . Berlin. |
| Architectural Record. <i>q</i> . New York. | Dingler's Polytechnisches Journal. <i>w</i> . Stuttgart. |
| Architectural Review. <i>s-g</i> . Boston, U. S. A. | Domestic Engineering. <i>m</i> . Chicago. |
| Architecture and Building. <i>w</i> . New York. | Eclairage Electrique. <i>w</i> . Paris. |
| Architektonische Rundschau. <i>m</i> . Stuttgart. | Electrical Engineer. <i>w</i> . London. |
| Australian Mining Standard. <i>w</i> . Sydney. | Electrical Engineering. <i>m</i> . Chicago, Ill. |
| Automotor and Horseless Vehicle Jour. <i>m</i> . London. | Electrical Review. <i>w</i> . London. |
| Berg-und Hüttenmännische Zeitung. <i>w</i> . Berlin. | Electrical Review. <i>w</i> . New York. |
| Brick Builder. <i>m</i> . Boston, Mass. | Electrical World. <i>w</i> . New York. |
| Bridges. <i>m</i> . Chicago. | Electrician. <i>w</i> . London. |
| British Architect. <i>w</i> . London. | Electricien. <i>w</i> . Paris. |
| Builder. <i>w</i> . London. | Electricity. <i>w</i> . London. |
| Bulletin Am. Iron and Steel Asso. <i>w</i> . Phila. | Electricity. <i>w</i> . New York. |
| Bulletin de la Société d'Encouragement. <i>m</i> . Paris. | Elektrochemische Rundschau. <i>b-m</i> . Frankfurt. |
| Bulletin of Dept. of Labor. <i>b-m</i> . Washington. | Elektrochemische Zeitschrift. <i>m</i> . Berlin. |
| Bulletin of the Univ. of Wisconsin, Madison, U.S.A. | Elektrotechnisches Echo. <i>w</i> . Magdeburg. |
| Bull. Int. Railway Congress. <i>m</i> . Brussels. | Electrotechniker. <i>b-m</i> . Vienna. |

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Elettricità. *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, U.S.A.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubbl. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Heating and Ventilating. *m.* New York.
 Horseless Age. *w.* New York.
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Engs. and Surveyors. Peoria, U.S.A.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
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 Locomotive. *m.* Hartford, U. S. A.
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 Machinery. *m.* New York.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Master Steam Fitter. *m.* Chicago.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U.S.A.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
 Ores and Metals. *w.* Denver, Colo.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York
 Proceedings Engineers' Club. *qr.* Phila.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Públicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, U. S. A.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* zürich
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, U. S. A.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Western Railway Club Pro. Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, U. S. A.
 Year Book of Soc. of Engs. Univ. of Minn.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Exposition.

The Buildings of the Paris Exposition of 1900. Jacques Boyer. The first paper describes the buildings on the Champs Elysees and the Champ de Mars, giving many illustrations showing the methods of erecting the structural framings. 3000 w. Engineering Magazine—June, 1899. No. 27897 B.

Fire-proofing.

Simple Rules for Figuring the Strength of Terra-Cotta Arches. Henri G. Chatain and W. M. Everett. A statement of facts and principles with as little mathematics as possible. Ill. 1600 w. Br Build—April, 1899. No. 27358 C.

Library.

The New Free Public Library, Jersey City, N. J. Illustrates and describes a large library building. 1400 w. Eng Rec—May 20, 1899. No. 27700.

Stable Construction.

The Strawbridge Stable, Germantown, Philadelphia, Pa. Illustrates and describes the remodeling of an old stable. 2000 w. Eng Rec—May 27, 1899. No. 27791.

HEATING AND VENTILATION.

Blowers.

Rating and Capacity of Blowers. Alton D. Adams. Notes the disagreement in rated capacities between blowers of the same size and different makes, and compares the several ratings as to air pressure, delivery and power of the same blower with each other and the known laws governing the movement of air. 2000 w. Arch & Build—May 27, 1899. Serial. 1st part No. 27782.

Exhaust Heating.

Heating with Exhaust Steam (Ueber Abdampfheizungen.) Hermann Fischel. With plans of various installations showing the method of using high-pressure steam in connection with a reducing valve in the same system as exhaust steam, when necessary. 3500 w. Zeitschr d Ver Deutscher Ing—May 6, 1899. No. 27821 D.

Furnace.

Hot Air Furnace. Martin L. Kaiser. Special prize essay. Illustrated description of method of school-house heating under conditions specified in a competition. 3500 w. Met Work—April 29, 1899. No. 27356.

Hospitals.

A Model Hospital. Frederick Baumann. Discusses the principles that

should govern hospital erection, with special reference to the heating and ventilation. 2500 w. In Arch't—May, 1899. No. 27673 F.

School.

Ventilation and Heating of a New York School. Illustrates and describes an interesting plant in a New York City school. The building is heated by direct radiation. 2000 w. Eng Rec—May 27, 1899. No. 27792.

Steam Heating.

Gravity Steam Heating Problems. Illustrated description of the method of solving a number of questions which arose during the installation of a plenum system in a British school-house. 1500 w. Eng Rec—May 6, 1899. No. 27511.

Ventilation.

Ventilation. R. H. Smith. Consideration of the methods and principles of the ventilation of buildings. 2800 w. Engr, Lond—May 5, 1899. No. 27612 A.

PLUMBING AND GAS FITTING.

Gas Fitting.

Gas Fitting as Required in Massachusetts. Illustrations which show methods of doing work in accordance with the new law licensing gasfitters and supervising the business of gas-fitting in the city of Boston. 150 w. Dom Engng—May, 1899. No. 27676 C.

Swimming Bath.

The New York Athletic Club's Swimming Bath. Illustrated description of a large tank built under difficult conditions. 2000 w. Eng Rec—May 20, 1899. No. 27701.

Thawing.

See Electrical Engineering, Heating.

MISCELLANY.

Acoustics.

The Acoustic Properties of Brick, Tile and Terra Cotta. Calls attention to the capabilities of these materials in assisting and modifying sound. 1500 w. Clay Rec—May 12, 1899. No. 27743.

Baths.

Public Douche Baths at Rouen and Paris (Les Bains-Douches à Bon Marché à Rouen et à Paris.) Paul Sarrey. A description of the inexpensive buildings and apparatus which have been found most effective in the promotion of public health and cleanliness in France. 3000 w. 1 plate. Genie Civil—May 6, 1899. No. 27805 D.

Painting.

Sanitary Painting. A. G. White. Ad-

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dress before the Master House Painters of England and Wales. The relation of painting to the health and life of buildings. 2000 w. *Sci Am Sup*—May 6, 1899. No. 27460.

Sanitary Law.

France's New Sanitary Law as Applied to Contractors and Builders. Comments on the hygienic precautions being enforced to prevent contagion, especially

during the preparatory work for the coming exposition in Paris. 1400 w. *Stone*—May, 1899. No. 27734 C.

Specifications.

Specifications. F. W. Macey. Read before the British Architects' Association. Suggestions of particulars that should be given, and matters affecting the clearness, order, etc. Discussion. 1500 w. *Builder*—May 6, 1899. No. 27633 A.

CIVIL ENGINEERING

BRIDGES.

Address.

The Profession of Bridge Engineering. A lecture by J. S. Deans on the proper training of an engineer to become a specialist in structural metal work. 3000 w. *Eng Rec*—May 6, 1899. No. 27509.

Alexander III.

The Alexander III. Bridge, Paris; Construction and Erection of Arch Ribs. Abstract of description from the *Annales des Ponts et Chaussées*, with two-page plate. 1800 w. *Eng News*—May 25, 1899. No. 27755.

Atbara Bridge.

The Atbara River Bridge. Interesting data concerning the erection of this bridge on the line of railroad now building in the Soudan, and the quick fulfillment of the order by an American company. Ill. 1200 w. *R R Gaz*—May 26, 1899. No. 27768.

Bridge Architecture.

The Architecture of Bridges. Illustrated review of forms of bridge construction and embellishment. 2700 w. *Bridges*—April, 1899. Serial. 1st part. No. 27620 C.

The Architectural Element in Engineering Work. H. H. Statham. Abstract of paper read before the Royal Inst. of British Arch'ts. Thinks the viaduct is to the 19th century what the cathedral was to the 12th, 13th and 14th centuries. Discusses various types of bridge architecture. 2000 w. *Archit, Lond*—May 19, 1899. No. 27799 A.

The Architecture of Bridges, Parapets and Balustrades. Illustrated discussion of principles of design suited to various materials. 2000 w. *Bridges*—May, 1899. No. 27683 C.

Bridge Engineering.

Some Examples of Bridge Engineering. Illustrated descriptions of a number of engineering crimes in Iowa, with an editorial introduction on the subject. 3500 w. *Eng Rec*—May 6, 1899. No. 27504.

Buffalo, N. Y.

Street Bridges Over Railroad Tracks in Buffalo. Illustrated description of the

important features of the largest bridges erected on the grade-crossing improvements of Buffalo. 2000 w. *Eng Rec*—May 13, 1899. No. 27578.

California.

Bridge Evolution as Relating to Southern California. C. E. Fowler. Part first is an introductory general review of progress in bridge design, especially of metal construction. Ill. 2000 w. *Bridges*—May, 1899. Serial. 1st part. No. 27682 C.

Culverts.

Culverts and Bridges. A. W. Campbell. Extract from a paper read before the Assn. of Ontario Land Surv's. Contrasts the practice in Canada with England in regard to the durability of structures; discusses the selection of a site, the size, materials, design, etc. 3000 w. *Can Engr*—May, 1899. No. 27556.

Designing.

Some Hints on Bridge Designing. Oscar Sanne. On the working out of details in a manner that will make a pleasing impression. 4000 w. *Jour W Soc of Engs*—April, 1899. No. 27691 D.

Drawbridge.

Draw-Span Stresses — Assumptions Made to Determine Them. Malverd A. Howe. A discussion of the question of making proper assumptions for the determination of stresses, and the methods in use at the present time. Ill. 3000 w. *Bridges*—April, 1899. No. 27619 C.

English Practice.

Recent English Practice in Bridges and Framed Structures. Alfred D. Ottewell. Illustrations with explanatory remarks. 2000 w. *Bridges*—May, 1899. No. 27681 C.

Estimating.

The Bridge Works' Estimating Department. E. M. Scofield. Suggests methods which have proved valuable in actual use. Ill. 2800 w. *Bridges*—April, 1899. No. 27621 C.

Highway.

The Greenpoint Avenue Bridge. Illustrated description of a low-level highway swing bridge for heavy city traffic. It is

about 200 feet in length, with a 20.5-foot roadway and two 5.75-foot sidewalks. 900 w. Eng Rec—May 27, 1899. No. 27785.

Niagara.

The New Bridge Over the Niagara River. General facts relating to the Atbara bridge so rapidly constructed, with detailed description of the Niagara bridge recently completed by the same company—the Pencoyd Iron Works, of Philadelphia. Ill. 3600 w. Engng—April 28, 1899. Serial 1st part. No. 27540 A.

Plate Girder.

Erection of a Plate Girder Span by Displacement. Illustrated account of the erection of a plate girder span by sliding it sidewise into the old position of a pony truss span, which was moved away at the same time. The new structure was used for train service while in transit. 900 w. Eng Rec—April 29, 1899. No. 27373.

CONSTRUCTION.

Beam.

The Determination of the Maximum Moment of a Simple Beam. (Bestimmung des Maximalmomentes Einfacher Trager.) Alexander Coulmas. A discussion by the graphical method, taking into account independent loads at various points. 2000 w. Zeitschr d Oesterr Ing u Arch Ver—April 14, 1899. No. 27828 B.

Bicycle Tracks.

Effect of Different Speeds and Radii of Curves Upon the Inclination of Bicycle Tracks. John C. Quade. Describes existing tracks and their construction, discusses the theory of bicycle-track construction, and considers the Garfield Park track in Chicago, and the Racine, Wis., track. 3000 w. Jour W Soc of Eng—April, 1899. No. 27690 D.

Eccentric Load.

Computation of a Column Subjected to an Eccentric Load. (Berechnung eines auf Excentrischen Druck Beanspruchten Stabes.) René Koechlin. With computations, based upon the elastic theory, for wrought iron, low steel, cast iron and wood. Two articles. 3000 w. Schweizerische Bauzeitung—May 6, 13, 1899. No. 27836 each B.

Foundations.

Pneumatic Caissons for Ordinary Foundations. A. W. Jones. Illustrates and describes the pneumatic work in connection with foundations of bridges. 5800 w. Bridges—April, 1899. No. 27618 C.

Groined Arch.

The Groined Arch as a Covering for Reservoirs and Sand Filters: Its Strength and Volume. Leonard Metcalf. The formulas given were deduced in connection with work at Somersworth, N. H.

A sketch of the development of the groined arch is also given and a description of a method for computing the strength. Ill. 6500 w. Pro Am Soc of Civ Eng—May, 1899. No. 27773 E.

Pile Driving.

Pile Driving Formulas: Their Construction and Factors of Safety. Charles H. Haswell. Deductions and opinions given are the results of observations of a varied and extensive experience of pile-driving in every variety of soil. 3700 w. Pro Am Soc of Civ Eng—May, 1899. No. 27772 E.

Roads.

Country Road Construction in Ireland. Description of the methods followed in building roads over bogs and uplands where only local limestone is available on account of expense. 3100 w. Eng Rec—May 13, 1899. No. 27580.

Good Roads in New York State. Describes the methods of construction and gives an account of what has been done. 1300 w. Eng Rec—May 20, 1899. No. 27699.

Water as a Road Maker. William M. Bristol. Describes a case where water was used in road construction. Ill. 900 w. Min & Sci Pr—May 20, 1899. No. 27778.

Simplon Tunnel.

Notes on the Driving of Simplon Tunnel, Swiss Alps. Leopold Meyer. A general outline of the work, describing the surface installations, mode of work for the driving and power used, the ventilation and refrigerating plant. 2200 w. Can Min Rev—April 29, 1899. No. 27404 B.

Tunnel.

A Great Underground Railway Undertaking. Reviews the proposed work of tunneling under the East River and a portion of Brooklyn. 1800 w. Eng Rec—May 20, 1899. No. 27696.

The New Treptow-Stralau Tunnel Under the Spree. From *Das Buch fur Alle*. Brief illustrated description of an important engineering work. 600 w. Sci Am. Sup—May 20, 1899. No. 27645.

The Passy Tunnel (Le Tunnel de Passy). A description of the tunnel works on the new railway between Courcelles and Passy, with plate showing timbering and masonry, and a plan of the route. 2000 w. 1 plate. Revue Technique—May 10, 1899. No. 27812 D.

Tunneling.

The Shield Used in Constructing the Orleans Railway Tunnel, Paris. Brief abstract translation from *Le Génie Civil*. Gives illustrated description of the shield and the methods of construction employed. 1300 w. Eng News—May 4, 1899. No. 27467.

HYDRAULIC AND MARINE.

Canals.

Comparison Between Three Proposed Routes Across the Isthmus. Thomas Wright Hurst. Considers these different routes in regard to harbors, distance, level, climate, and troublesome rivers and lakes. 4800 w. Clay Rec—May 12, 1899. No. 27742.

New York State Canals. A statement of the five possible solutions under consideration by the committee appointed by the governor. 1500 w. Marine Rec—May 18, 1899. No. 27702.

Railway Competition with Canals in New York. Extracts from the circular letter issued by the commission appointed by the governor to investigate the canal question, with editorial comment on the problem. 3500 w. Eng News—May 11, 1899. No. 27596.

The Future of the New York State Canals. A statement of the relative merits of estimates for various improvements. 2000 w. Eng Rec—May 13, 1899. No. 27577.

The New Canal Plans. (Die Neue Kanal-Vorlage.) A special number devoted entirely to the Rhine-Elbe canal question, with a number of fine maps. 7500 w. 10 plates. Glückauf—April 8, 1899. No. 27859 G.

The Rhine-Elbe Canal. (Der Rhein-Elbe-Kanal.) A general account of the proposed waterway to connect the Elbe and the Rhine, with especial reference to the action of the German Government. 3000 w. Stahl und Eisen—April 15, 1899. No. 27852 D.

Dam.

Failure of Dam at Minneapolis Due to Previous Weakening Through Ice Pressure. James W. Rickey. An illustrated account of the failure of a portion of the main dam which controls the falls of the Mississippi River. 800 w. Eng News—May 11, 1899. No. 27598.

Failure of a Minneapolis Dam by Ice Pressure. Illustrated description of the overthrow of a stone wing dam after it was weakened by ice pressure. 1100 w. Eng Rec—May 13, 1899. No. 27579.

The Indian River Dam. George W. Rafter, Wallace Greenalch, and Robert E. Horton. Gives facts relating to the water storage in this Adirondack region, and a general description of the area; also an illustrated description of the construction of the dam. 9500 w. Eng News—May 18, 1899. No. 27668.

The Ochoa Dam. Illustrates and describes the nature of the structure which forms the key to the latest proposition for a Nicaragua Canal, with typical cross-sections of the canal. 700 w. Eng Rec—May 13, 1899. No. 27581.

Drainage Canal.

The Protest of St. Louis Against the Chicago Canal. Review of the report of a commission appointed to investigate the effect of the use of the Chicago canal on the interests of St. Louis. 1800 w. Eng Rec—April 29, 1899. No. 27371.

Drain Tile.

The History of Drain Tile and Its Uses. Thomas Townley. Deals principally with the use of tile in land drainage. 4000 w. Brick—May 1, 1890. No. 27485.

Dredging.

Experiments with the Kretz Jet Dredge. (Versuchsfahrten mit dem Kretzschen Spülbagger). With illustrations showing the combined action of the forcing and suction streams. 3500 w. Zeitschr d Ver Deutscher Ing—May 13, 1899. No. 27825 D.

Graving Dock.

Performances of Pumping Machinery: Clyde Trustees' No 3 Graving Dock. George H. Baxter. Extract from a paper read before the Inst. of Engs. and Shipbuilders in Scotland. Facts and analyses as to the performances of the machinery of one of the largest graving docks in the world. 900 w. Engr, Lond—April 28, 1899. No. 27537 A.

Hydrant Rentals.

New Judicial Light on Hydrant Rentals. A Michigan decision, holding that in the absence of a contract, 8 per cent. on the cost of the necessary plant is the proper charge. 600 w. Eng Rec—May 20, 1899. No. 27695.

Lighthouse.

Lighthouse Illuminants. Lawrence Irwell. Discusses the use of oil, gas and electricity. 1800 w. Marine Rec—May 4, 1899. No. 27490.

Locks.

Hydraulic Lift Lock on the Trent Canal. Illustrated description of the balanced lift locks at Peterborough, Canada, which consist of two chambers 139 feet long, 33 feet wide, and 8 feet deep, raised and lowered through a distance of 65 feet by means of a hydraulic ram beneath each. 2400 w. Eng Rec—April 29, 1899. No. 27372.

River Improvement.

The Improvement of the Great Kanawha River. W. Va. Illustrates and describes the government improvements, which aim to furnish a depth of at least 6 feet of water over the entire length throughout the whole of the year. 2500 w. Eng Rec—May 27, 1899. Serial. 1st part. No. 27784.

Valves.

New Air-Relief and Pressure-Relief Valves. Illustrated description of new forms of valves for water mains. 900 w. Eng. Rec—April 29, 1899. No. 27374.

Waste.

Waste of Water at Erie, Pa. A statement of conditions existing in this city, showing that more water is wasted than used. Ill. 1400 w. Fire & Water—May 6, 1899. No. 27516.

Water Mains.

Moving Large Mains in Service. Illustrated description of the apparatus and methods employed in Philadelphia in moving mains up to 48 inches diameter. 1600 w. Eng Rec—April 29, 1899. No. 27375.

Water Meterage.

Meterage for Pittsburgh. A statement of conditions affecting the amount of water used and wasted in this city, and the recommendations of Mr. Allen Hazen in his report to the commission on filtration. 2300 w. Fire & Water—May 13, 1899. No. 27625.

Water Power.

Reform in Water-Power Rights in Austria. (Reform des Oesterreichischen Wasserrechtes.) Dr. Ernst Seidler. A discussion of the growing importance of water power and the legislation controlling its use in Austria. 3000 w. Oesterr Zeitschr f Berg u Huttenwesen—April 15, 1899. No. 27862 B.

Water Works.

A Large Artesian Well Plant at Camden, N. J. Describes a plant having a contract capacity of 20,000,000 gallons. 1200 w. Eng News—May 11, 1899. No. 27595.

How the Water-Supply of the City of Syracuse Is Kept from an Unpleasant Taste. W. R. Hill. Read before the American Water-Works Assn. Describes a simple operation by which the water has been kept free from vegetation. 2000 w. Fire & Water—May 20, 1899. No. 27693.

London Water Supply. Walter Hunter. Reviews the history of the supply, giving a descriptive summary of the works, discussing the future outlook. Discussion. 15500 w. Jour Soc of Arts—April 21, 1899. No. 27412 A.

Progress of the Metropolitan Water Works. Interesting information from the annual report of the Metropolitan Water Board of Massachusetts, covering the work done in 1898. 3200 w. Eng Rec—May 27, 1899. No. 27783.

Some Difficulties in Obtaining a Water Supply. Abstract of a paper by W. J. Milner, read at a meeting of the Am. Water Works Assn. On the difficulties met and overcome in supplying Birmingham, Ala., with water. Ill. 1600 w. Eng Rec—May 27, 1899. No. 27786.

The History of an Amateur Water-Works Plant. An account of the misfortunes of a plant erected without other

engineering advice than that of the sales agent of a gas-motor firm. 1300 w. Eng Rec—May 13, 1899. No. 27582.

The New Water-Works of Camden, N. J. Illustrated description of a driven-well plant of about 16,000,000 gals. daily capacity, in which the details include special air-lift connections, pump well, submerged pipe laying and a concrete chimney cap. 300 w. Eng Rec—May 6, 1899. No. 27507.

MATERIALS.**Cement.**

Fineness of Cement. Ira O. Baker. Gives reasons why cement should be well ground, data on fineness, and method of selecting the most economical cement. 1200 w. Br Build—April, 1899. No. 27359 C.

Report on the Constancy of Volume of Ten Portland Cements. (Bericht über die Raumbeständigkeit von Zehn Portland cementen.) M. Gary. A very full report by the Berlin Testing Laboratory and the German Society of Cement Manufacturers, upon the general properties of the cements, including the changes in volume under various conditions. An important document. 18000 w. 2 plates. Mill aus den Kgl Tech Versuchsanstalt—Part I. 1899. No. 27858 G.

Cement Works.

The Vulcanite Portland Cement Company's Works. Frederick H. Lewis. Illustrates and describes a new plant for the manufacture of Portland cement, containing many new features for economical working, proved desirable by experience with an older plant at the same site, of which plans are also published. Particular attention is paid to the power plant details, which affect the cost of cement in a marked degree. 2000 w. Eng Rec—May 6, 1899. No. 27505.

Concrete Masonry.

See Railway Affairs, Permanent Way.

Inspection.

The Inspection of Iron and Steel, Its Development, What It Is, and Its Advantages. Frank C. Osborn. A brief description of the methods adopted by the Osborn Co., of Cleveland, O., illustrating the care taken in testing the materials. 3000 w. Bridges—May, 1899. Serial. 1st part. No. 27680 C.

MUNICIPAL.**Filtration.**

A New Coagulant for Mechanical Filters. Describes the plant at Quincy, Ill., where the iron process is used with satisfactory results. 1000 w. Eng Rec—May, 27, 1899. No. 27789.

The Purification of Surface Water by Sand Filtration During Cholera Epidemic. (Grundsätze für die Reinigung von Obseflächenwasser durch Sandfiltration

zu Zeiten den Cholera-gefahr.) An abstract of the German government report with extracts showing the conditions to be maintained and the precautions necessary. 2500 w. *Gesundheits-Ingenieur*—April 15, 1899. No. 27856 B.

Cincinnati and Its Filtration Report. A statement of the conclusions reached as regards the English and American filtration systems. 450 w. *Fire & Water*—April 29, 1899. No. 27388.

The Cost of Filtration. Considers the estimates recently sent in by the filtration commission of Pittsburg, Pa., with a few words on the experience in Cincinnati. 1500 w. *Fire & Water*—April 29, 1899. No. 27387.

The Present Status of Water Filtration. Paper of George W. Fuller before the American Water Works Assn., reviewing the conditions found in many places in America, and their influence on purification work. 2000 w. *Eng Rec*—May 27, 1899. No. 27788.

Garbage Disposal.

Refuse Cremation at Edinburgh, Bradford and Oldham. An illustrated report by Lord Kelvin and Prof. A. Barr, on the construction and operation of the plants in the cities named. 4000 w. *Eng Rec*—May 6, 1899. No. 27510.

Mill-Drainage.

The Discharge of Hot Mill-Drainage into City Sewers. (Die Einführung Heisser Fabrikabwässer in Stadtische Kanäle.) Showing the effect of hot discharges in producing decomposition of sewage, and affecting public health. The safe limit of temperature is placed at 40° C. 2000 w. *Gesundheits-Ingenieur*—April 30, 1899. No. 27857 B.

Municipal Undertakings.

Municipal Notes. Illustrated description of various novel water, sewer and paving undertakings in a number of cities. 3500 w. *Eng Rec*—May 6, 1899. No. 27506.

Rain.

Tables of Excessive Precipitations of rain at Chicago, Ill., from 1889 to 1897, inclusive. Discussion on paper of Edwin Duryea, Jr. 20000 w. *Jour W Soc of Engs*—April, 1899. No. 27688 D.

Refuse.

The Utilization of City Refuse. W. F. Morse. Brief notes on the success attained in utilizing the heat from the burning of refuse. 1000 w. *Munic Engng*—May, 1899. No. 27379 C.

River Pollution.

Alleged River Pollution by the Bath Gas Company. A statement of a case in the English courts. Judgment not given. 5000 w. *Gas Wld*—May 13, 1899. No. 27712 A.

Russia.

Sanitation in Russia. Notes and observations on sanitary conditions in Russia. 4300 w. *Am Arch*—May 20, 1899. Serial. 1st part. No. 27692.

Sewage Regulator.

Sewage Regulator at Cambridge, Mass. Illustrated description of an apparatus used to regulate the flow of sewage into a main interceptor, and a device for automatically registering the state of the regulator. 600 w. *Eng Rec*—April 29, 1899. No. 27376.

Sewerage.

Perfect Sewerage and Perfect Health. Papers by W. R. Morrison, and by Graham M. Sinclair. Considers the essentials of a perfect system. 2800 w. *San Plumb*—May 1, 1899. No. 27487.

Portishead Sewerage Scheme. Detailed description of a system recently completed. The sewage is discharged into the Severn a third of a mile from the shore under conditions so favorable as to make it unobjectionable. 2800 w. *San Rec*—April 28, 1899. No. 27519 A.

Sewage Analysis and the Chemical Treatment of Sewage. Leonard P. Kinicutt. Considers what sewage is and how an idea of its character is obtained, and the amount of purification accomplished by different methods of treatment. Gives special information concerning the chemical treatment. 5000 w. *Eng News*—May 11, 1899. No. 27594.

Sewage Disposal at Glasgow. James H. Fuertes. Illustrated description of works for treating 12,000,000 gals. daily by chemical precipitation and filtration through sand and coke. 2000 w. *Eng Rec*—May 20, 1899. No. 27697.

The Relation of Manufacturing Wastes to the Sewerage Problem. F. Herbert Snow. Abstract of a paper presented before the Civil Engs.' Club of Columbus, O. Gives a digest of experiments for purifying these wastes, made by the Mass. Bd. of Health, and other comments on the question of nuisance. 2000 w. *Eng News*—May 25, 1899. No. 27758.

The Shone Sewerage System at Karachi. Facts taken from a paper by James Strachan presented to the Institution of Civil Engs. Describes features of interest and gives the results of efficiency tests. 2000 w. *Eng Rec*—May 27, 1899. No. 27787.

Village Sewerage Schemes. Rev. Dr. Cox. Experiments in the rural district of Brixworth, Eng., giving attempts and failures. 2500 w. *Jour San Inst*—April, 1899. No. 27454 F.

Sewer Pipe.

Sewer Pipe: Its Manufacture. Anton Vogt. Part first considers the setting of the pipes in the kiln. 2400 w. *Brick*—

May 1, 1899. Serial. 1st part. No. 27-486.

Sewers.

Experience in Sewer Construction. L. M. Hastings. Notes experiences gained in the city of Cambridge, Mass., bearing on the difficulty of excavating and maintaining trenches, and expensive bracing and other work affecting the character and cost of the system. Ill. Discussion. 4500 w. Jour Assn of Engng Socs—March, 1899. No. 27382 C.

Maintenance of the System of Separate Sewers at Newton, Mass. Stephen Childs. Describes the system, the underdrains, flushing, ventilation, etc. Discussion. Ill. 7800 w. Jour Assn of Engng Socs—March, 1899. No. 27383 C.

Street-Cleaning.

Street Cleaning in San Francisco. A statement of the methods employed at the recommendation of the local Merchants' Assn. Hand-cleaning is preferred and the contractor is required to treat his men in a specified manner. 2000 w. Eng Rec—May 6, 1899. No. 27508.

Street Widening.

Proposed Widening of New York Streets. N. J. Vander Weyde. Map with explanation of needed changes. 450 w. Sci Am Sup—May 6, 1899. No. 27461.

Swimming Baths.

An Open-Air Swimming Bath-House. Illustrates and describes a Philadelphia

bath having a capacity of about 100 bath-ers per hour, which has attracted considerable attention on account of its utility. 1600 w. Eng Rec—April 29, 1899. No. 27378.

MISCELLANY.

Drainage Plant.

Gasoline Engine Drainage Plants at Sixteenth Street Crossing, Chicago. Illustrates and describes the manner of solving a difficult problem in the disposal of surface water. 700 w. Ry & Engng Rev—May 13, 1899. No. 27624.

Engineering Societies.

The Austrian Society of Engineers and Architects. A brief review of the half-century's work of this great national organization. 1300 w. Eng Rec—May 6, 1899. No. 27503.

Niagara.

Niagara as an Industrial Center. The first of a series of articles descriptive of the topographical and engineering features. Map. 2300 w. Sci Am—May 27, 1899. Serial. 1st part. No. 27764.

Public Works.

National Public Works. George Y. Wisner. Read at a recent meeting of the Detroit Engng. Soc. Criticism of the policy of the United States which has kept the public funds under the control of the army engineer corps, with a history of the work. 3800 w. Marine Rev—May 11, 1899. No. 27589.

ELECTRICAL ENGINEERING

COMMUNICATION.

Auxiliary Circuits.

Auxiliary Circuits as Applied to the Commercial Telephone. H. P. Clausen. Illustrates and describes circuits and apparatus that may be applied with advantage, particularly to business house telephones. 2400 w. Elec Engng—May, 1899. No. 27706.

Cable Faults.

A Method of Detecting the Arrival of Faults on Board When Picking Up Submarine Cables. Walter J. Murphy. Illustrates and describes devices experimented with by the writer but not tested by actual practice to any great extent. 1000 w. Elect'n, Lond—April 28, 1899. No. 27525 A.

A New Method of Finding an Insulation Fault in a Submarine Cable While Raising for Repairs. E. Jona. Illustrates and describes a method that has given good results. 1600 w. Elect'n, Lond—April 28, 1899. No. 27526 A.

Cables.

See Measurement.

Charges.

The Exorbitant Charges for Telegrams to India and the Far East. Discusses the reasons for the unreasonable charges for telegrams between England and the Far East. 1200 w. Elec Rev, Lond—April 28, 1899. No. 27530 A.

Composite Circuit.

Simultaneous Telephony and Telegraphy. Charles Selden. Read before the Railway Telegraph Supts.' Assn. Reports experimental investigations of the method of Francois Van Rysselberghe. 2000 w. Elec Rev, N. Y.—May 24, 1899. No. 27767.

Fire Alarms.

The Evolution of the Fire Alarm Telegraph. P. R. Colpitt. Read before the Maritime Electrical Assn. at Halifax. Describes the system as it is to-day, and the various stages of improvement by which it reached the present perfection.

2500 w. Can Elec News—May, 1899. No. 27559.

Japan.

Electrical Notes from Japan. F. B. Crocker. Considers the telegraph, telephone, electric light, electric power, electric railway, electrical manufacturing and education. Part first considers the telegraph. 2500 w. Elec Wld & Elec Engr—May 20, 1899. Serial. 1st part. No. 27679.

Multiple System.

The Mercadier Multiple Telephone System. (Mercadier's Vielfach-Gegensprechsystem.) Describing improvements in the monotelephone system by means of which multiplex messages can be sent in opposite directions. Three articles. 7000 w. Elektrotech Zeitschr—April 27, May 4, 11, 1899. No. 27875 each B.

Space Telegraphy.

Aetheric Telegraphy. W. H. Preece. Showing that wireless telegraphy has passed the experimental stage and reached practical use. Discussion. 5000 w. Jour Soc of Arts—May 5, 1899. No. 27630 A.

Marconi System in Chicago. An illustrated account of the very successful test made in a city crowded with steel structures, electric circuits and electric apparatus. 1800 w. W Elect'n—April 29, 1899. No. 27400.

Prof. D. E. Hughes's Researches in Wireless Telegraphy. A letter concerning the priority of the invention of wireless signalling, giving an account of the writer's researches as early as 1879. 2400 w. Elect'n, Lond—May 5, 1899. No. 27634 A.

Radioconductors with Metallic Balls. (Radioconducteurs à Billes Metalliques.) E. Branly. A note to the French Academy describing M. Branly's early and more recent experiments with various forms of coherers. 1200 w. Comptes Rendus—May 1, 1899. No. 27845 D.

The South Foreland Wireless Telegraph Station. Illustrates and describes this station with some comments on Mr. Marconi's experiments. 2000 w. Elect'n, Lond—April 28, 1899. No. 27524 A.

The Theory of Wireless Telegraphy. M. Blondel, in the Comptes Rendus de l'Association Francaise pour l'Avancement des Sciences. Attributes the principal effect to an oscillating system. 1100 w. Elec Rev, Lond—May 5, 1899. No. 27636 A.

Wireless Telegraphy. Reviews editorially what has been accomplished in this form of communication. 1200 w. Eng Rec—May 20, 1899. No. 27694.

Telediagraph.

Pictures by Telegraph. Describes the new system, called the telediagraph, for sending drawings by means of electricity.

Ill. 1200 w. Elec Rev, N. Y.—May 3, 1899. No. 27488.

Telephone.

A Telephone System without Return Battery Current. (Fernsprechanlage ohne Rufstromquellen bei den Teilnehmerstellen.) G. Ritter. An illustrated account of an improved system in which batteries are required at the central station only. Three papers, 12,000 w. Elektrotech Zeitschr—April 6, 13, 20, 1899. No. 27867 each B.

Reminiscences. F. A. Hamilton. Read before the Maritime Elec. Assn., at Halifax. On the uses and applications of the telephone, containing valuable suggestions. 1800 w. Can Elec News—May, 1899. No. 27560.

The Long Distance Transmission of Speech. J. H. Winfield. Read before the Maritime Elec. Assn., at Halifax. Notes some of the difficulties encountered in the design, construction and operation of long lines. 1600 w. Can Elec News—May, 1899. No. 27562.

Treasury Minute Upon the Proposals for the Development of the Telephone System in the United Kingdom. Full text, setting forth the proposals of the British Government with regard to the telephone service. 1200 w. Elect'n, Lond—May 19, 1899. No. 27797 A.

DISTRIBUTION.

Alternating Currents.

Alternating Electric Currents. Alton D. Adams. Illustrated explanation of alternating currents, showing that they are essentially different from the direct only in their periodic change of direction. 2700 w. Engr, U. S. A.—May 15, 1899. Serial. 1st part. No. 27627.

House Service.

House Service for Alternating Currents. (Ueber Hausanschlüsse bei Wechselstromwerken.) R. Helm. An illustrated description of methods used in Germany for connecting residences and apartments with underground high-tension alternating conductors. 2500 w. Elektrotech Zeitschr—April 6, 1899. No. 27865 B.

Mains.

Miscellaneous Notes on the Cheltenham Mains. Hamilton Kilgour. Read before the Northern Soc. of Elec. Engs. (England.) Describes the distributing works of electric supply at Cheltenham in part first. Ill. 2200 w. Elec Eng, Lond—May 12, 1899. Serial. 1st part. No. 27713 A.

Polyphase Apparatus.

Polyphase Electrical Apparatus. Cecil P. Poole. Illustrates and describes various forms and their operation. 4400 w. Power—May, 1899. No. 27770.

Rectifier.

The Design of a Single-Phase Rectifier. J. C. Brocksmith. States the more important requisites for a rectifier, and gives working drawings and description for the construction. 2800 w. *Am Elect'n*—June, 1899. No. 27740.

Safety Appliances.

A New System of Safety Appliances. (Ueber ein Neues System von Sicherheitsmaterialien.) H. Dressler. Describing a variety of fuses designed to meet the requirements of the German Elektrotechnical Association. 3000 w. *Elektrotech Zeitschr*—May 4, 1899. No. 27878 B.

Stations.

Limited Electric Stations. Alton D. Adams. Considers methods of distribution and gives facts showing the growing preference for direct electric distribution over moderate areas. 2500 w. *Am Elect'n*—June, 1899. No. 27738.

Three-Phase.

Secondary Distributing Systems for Three-Phase Plants. Aug. J. Bowie, Jr. Briefly notes the six systems, with their advantages and disadvantages. 1700 w. *Elec Wld & Elec Engr*—April 29, 1899. No. 27362.

ELECTRO-CHEMISTRY.**Alkali Works.**

The Electrolytic Alkali Works at Clavaux, France. John B. C. Kershaw. Describes the Hulin process and the works at Gavet Clavaux. Ill. 1700 w. *Eng & Min Jour*—April 29, 1899. No. 27367.

Chemistry.

The Electric Current in Chemistry. Part first reviews early discoveries, recalling the labors of eminent investigators, and the results won by them. 1500 w. *Elec Rev, Lond*—April 28, 1899. Serial. 1st part. No. 27529 A.

Electrical Energy.

Electrical Energy Produced Directly from Carbon. D. Tommasi. Describes the writer's battery and its theory. 1000 w. *Elec Rev, Lond*—May 12, 1899. No. 27715 A.

Electrolysis.

An Electrolytic Method of Obtaining the Halogen Salts of the Alkalies. (Ueber ein Elektrolytisches Verfahren zur Gewinnung der Chlor-Brom-und Iodsauren Salze der Alkalien.) Dr. E. Müller. Giving data as to solutions, electrodes, currents and operative details, as successfully employed by the author at the laboratory of the Dresden Polytechnic. 2500 w. *Zeit f Elektrochem*—April 13, 1899. No. 27879 G.

Osmotic Pressure, Dissociation, and Electrolysis. W. Bettel. A contribution to the discussion on Prof. von Oettingen's

paper. 4500 w. *Jour of Chem & Met Soc of S. Africa*—March, 1899. No. 27665 E.

Ozone.

Experiments in the Sterilization of Water by Ozone. Emile Andreoli. The conditions under which the sterilization can be effected, and an account of experiments which demonstrated the powerful action of ozone as a germicide. 1600 w. *Elec Rev, Lond*—May 5, 1899. No. 27637 A.

ELECTRO-PHYSICS.**Conductivity.**

The Conducting Analogy Between the Electric Arc and Certain Metallic Oxides. William Becket Burnie and Charles A. Lee. An account of experiments made to exhibit points of resemblance and dissimilarity between the arc and the oxides. 2000 w. *Elect'n, Lond*—May 12, 1899. No. 27717 A.

High Potential.

On the Decomposition of a High Potential Current. (Sur la Décomposition d'un Courant à Haut Potential.) H. Abraham. A communication to the French Academy recording the results of experiments with disruptive discharges produced by currents of high potential. 1500 w. *Comptes Rendus*—April 17, 1899. No. 27844 D.

Interrupter.

A Contribution to the Study of the Wehnelt Interrupter. (Contribution à l'Etude de l'Interrupteur Wehnelt.) H. Armagnat. An examination of the nature of the electrolytic action and the causes of the interruption and re-establishment of the circuit. 1000 w. *Comptes Rendus*—April 17, 1899. No. 27843 D.

A New Form of Wehnelt Interrupter. Elihu Thomson. Describes and illustrates a device embodying both anode and cathode, resembling somewhat a pencil. 300 w. *Elec Wld & Elec Eng*—May 6, 1899. No. 27493.

Improvements in the Wehnelt Interrupter. (Perfectionnements à l'Interrupteur Electrolytique de Wehnelt.) J. Carpenter. A brief note to the French Academy describing the effect of operating the Wehnelt interrupter at elevated temperatures. 800 w. *Comptes Rendus*—April 17, 1899. No. 27842 D.

Some Conditions of Action of the Wehnelt Interrupter. (Quelques Conditions de Fonctionnement de l'Interrupteur Electrolytique de M. Wehnelt.) Paul Bary. A communication to the French Academy giving the results of a number of experiments. 1000 w. *Comptes Rendus*—April 10, 1899. No. 27839 D.

Some Experiments with the Caldwell Interrupter. Charles T. Child. Illustrated description, with suggested theory. Also brief note from Harris Goldstein. 1000 w.

Elec Rec, N. Y.—May 10, 1899. No. 27-570.

The Liquid Interrupter. A discussion of this instrument by Elihu Thomson, E. W. Caldwell, and others. 1300 w. Elec Rev, N. Y.—May 17, 1899. No. 27655.

Magnetism.

Magnetism. J. A. Ewing. The "James Forrest" lecture, delivered at the Inst. of Civ. Engs., London. Part first is mostly a historical review of the developments and applications and early discoveries. 4600 w. Elect'n, Lond—April 28, 1899. Serial. 1st part. No. 27527 A.

Terrestrial Magnetism, and the Deviations of the Compasses of Iron Ships. John E. Davies. A review of investigations and progress in the study of terrestrial magnetism and its distribution, and of the deviations of a ship's compass. Ill. 5700 w. Wis Engr—May, 1899. No. 27-661 D.

Radiation.

Electrical Radiation. Arthur V. Abbott. Considers the general qualifications of transmitting and receiving apparatus, and the practical operation of signalling by electrical waves. Ill. 6800 w. Jour W Soc of Engs—April, 1899. No. 27689 D.

Electrical Radiation. J. E. Taylor. The article aims to throw more light on the mystery of wireless telegraphy. 2000 w. Elec Rev, Lond—May 12, 1899. Serial. 1st part. No. 27716 A.

Resistance.

The Variations in Electrical Resistance of Metals and Alloys from Torsion. (Sur la Variation de la Résistivité Electrique des Metaux et de leurs Alliages Due à la Torsion.) Coloman de Szily. A note to the French Academy, giving the results of experiments with various metals and alloys. 1200 w. Comptes Rendus—April 10, 1899. No. 27840 D.

Waves.

Propagation of Long Electrical Waves. M. I. Pupin. Describes an experimental method of investigating the propagation of long electrical waves and discusses the mathematical theory bearing upon the same. 9900 w. Trans Am Inst of Elec Engs—March, 1899. No. 27458 D.

GENERATING STATIONS.

Bootle, Eng.

Bootle Electricity Works. Illustrated detailed description and historical account. 1300 w. Elec Eng, Lond—April 21 and 28, 1899. Serial. 2 parts. No. 27415 each A.

Boston, Mass.

Central Station of the Boston Electric Light Company. Illustrates and describes this station as a solution of the problem of alternating current and series arc gen-

eration and distribution on a large scale. 3000 w. Am Elect'n—June, 1899. No. 27739.

Charges.

Notes on Methods of Charging for Electric Service. (Bemerkungen zur Tarifffrage bei Electricitätswerken.) K. Wilkens. A development of practical formulas by which the prices to be charged to customers may be derived from the cost data of the station. 2500 w. Elektrotech Zeitschr—April 13, 1899. No. 27869 B.

Cologne.

Statistics of the Electric Plant at Cologne. (Städtisches Electricitätswerk zu Köln.) A full report of the work of the Cologne station, both for light and power, fully tabulated, in comparison with previous years. 2500 w. Elektrotech Zeitschr—April 6, 1899. No. 27868 B.

Dynamos.

Bipolar and Multipolar Construction. Alton D. Adams. Aims to point out certain features in which bipolar are inferior to multipolar dynamos as at present made. 1400 w. Elec Wld & Elec Engr—April 29, 1899. No. 27366.

Mechanical Stresses on Dynamo Coils. P. M. Heldt. An explanation of the phenomenon observed, with proof of the subject in general and investigation of a few special cases. Ill. 2200 w. Elec Wld & Elec Engr—May 27, 1899. No. 27780.

English Stations.

Some English Central Stations. Illustrates and describes features of central station engineering differing from American practice. 3800 w. Am Elect'n—June, 1899. No. 27735.

Field Magnets.

On the Dimensioning of Field Magnets. George T. Hanchett. Enumerates the requirements and conditions in designing field magnets, and explains a method for determining with accuracy the length for the magnetic circuit. 1000 w. Elec Wld & Elec Engr—April 29, 1899. No. 27-364.

Hammersmith, Eng.

Hammersmith Electricity Works Extension. An illustrated account of the extension of these supply works. 2800 w. Elec Rev, Lond—April 21, 1899. No. 27-418 A.

Interrupter.

Pneumatic Interrupter for Accumulator Conductors. (Pneumatischer Stromunterbrecher für Akkumulatoren-Ladestromkreise.) Describing the Petersen apparatus, in which the pneumatic pressure caused by the accumulation of gas in a closed cell interrupts the connection when the battery is charged. 1000 w. Elektrotech Zeitschr—May 4, 1899. No. 27877 B.

Municipal Plant.

Estimate for a 1,537-Light Municipal Electric-Lighting Plant for San Francisco, Cal. Abstract of a report submitted to the Mayor and Board of Supervisors of the city, by A. W. Hunt, the consulting engineer. 800 w. Eng. News—May 25, 1899. No. 27757.

The Municipal Electric Light and Water Plant of Madison, N. J. Describes and illustrates a small attractive municipal station. 1300 w. Am Elect'n—June, 1899. No. 27736.

Paderno.

The Electric Power Plant at Paderno, on the Adda. (Die Elektrische Kraftübertragungs-Anlage Paderno d'Adda-Mailand.) An illustrated account of the Paderno power plant by which 13,000 h.p. is taken from the Adda for transmission to Milan, 21 miles distant. Serial. 1st part. 2500 w. Schweizerische Bauzeitung—May 13, 1899. No. 27837 B.

Portland, Me.

Power Transmission Plant in the Maine Woods. Illustrates and describes the electric power transmission plant of the Cumberland Illuminating Co., of Portland, Me. 2000 w. Elec Wld & Elec Engr—April 29, 1899. No. 27361.

Private Station.

A Private Central Station. Illustrates and describes the monocyclic isolated plant of the Frank Jones Electric Light Station of Portsmouth, N. H. 1700 w. Am Elect'n—May, 1899. No. 27481.

Transformers.

The Ziperowski-Déri-Blathy Transformer Distribution Patents. Text of two patent specifications that have recently expired, which, it is claimed cover the general principles governing practical transformer construction and alternate-current distribution. 2400 w. Elect'n, Lond—April 21, 1899. No. 27419 A.

Transformer Core Losses. W. Elwell Goldsborough. On the improvements in transformers and the effect of the apparatus on the earning capacity of plants, showing the gain that follows the substitution of modern transformers for the antiquated types. 3300 w. Elec Wld & Elec Engr—May 20, 1899. No. 27678.

Transformer Testing for Central Stations. J. H. Perkins. The paper points out the extensions and changes which practice has shown to be desirable in the methods used. 2500 w. Wis Engr—May, 1899. No. 27657 D.

HEATING AND WELDING.**Thawing.**

Thawing Frozen Water Pipes by Electricity. Abstract of a paper by John B. Heim, read at meeting of the American

Water Works Assn. 1700 w. Eng Rec—May 20, 1899. No. 27698.

LIGHTING.**Arc Lamps.**

The Arc Lamp Department of the Central Station Business. H. W. Hillman. Suggestions as to the organization and conduct of such a department. 5000 w. Elec Rev, N. Y.—May 3, 1899. No. 27489.

Triple Connection of Arc Lamps. (Ueber die Dreierschaltung von Bogenlampen.) W. Wedding. A record of electrical and photometric measurements made upon the Korting and Mathiesen arc lamps connected three in series. 2500 w. Elektrotech Zeitschr—April 13, 1899. No. 27870 B.

Candle Power.

The Candle Power of Arc and Incandescent Lamps. Wilbur M. Stine. Considers the leading standards of illuminating power proposed. 1400 w. Am Elect'n—June, 1899. No. 27737.

Light Baths.

Electric Light Baths. Brief account of the appliances used in giving these baths, and their advantages. 800 w. Elect'n, Lond—May 5, 1899. No. 27635 A.

Nernst Lamp.

The American Nernst Lamp Patent. An account of the principles of the Nernst lamp as contained in the American patent. 1300 w. Elec Wld & Elec Engr—April 29, 1899. No. 27360.

Theatre Lighting.

Electric Lighting of Covent Garden Theatre. Illustrated detailed description of the alterations in lighting which are being made, changing from an antiquated gas service to electric lighting. 2400 w. Elec Eng, Lond—May 5, 1899. No. 27638 A.

MEASUREMENT.**Cables.**

Capacity Measurements of Long Submarine Cables. J. Elton Young. Read before the Brit. Inst. of Elec. Engs. A critical comparison of Gott's, Thompson's and Muirhead's methods. 2000 w. Ind & Ir—May 5, 1899. Serial. 1st part. No. 27601 A.

Capacities.

Relative Dynamo and Motor Capacities. Alton D. Adams. On the method of determining the capacity of a given dynamo when used as a motor and vice versa. 1500 w. W Elect'n—April 29, 1899. No. 27401.

Dynamo Testing.

A Simple Method of Testing Dynamos. (Ueber eine Einfache Methode zur Prü-

fung von Dynamomaschinen.) C. Liebenow. Advocating the periodical testing of dynamos in the same systematic manner as is applied to engines and boilers and outlining a system. 3000 w. *Elektrotech Zeitschr*—April 13, 1899. No. 27871 B.

Dynamo Tests for Efficiency. Arthur L. Rice. An explanation of what efficiency is, and the best method of computing it. 2400 w. *Engr, U. S. A.*—May 1, 1899. No. 27455.

Meters.

Electric Meters. R. T. MacKeen. Read before the Maritime Elec. Assn., at Halifax. On the service and care of meters, the need of inspection, etc. 2000 w. *Can Elec News*—May, 1899. No. 27561.

Oscillograph.

Recent Experiments with the Oscillograph. Andre Blondel. Abstract translation from *L'Industrie Electrique*. Reports recent progress in the construction of the two principal types of this apparatus. 2500 w. *Elec Rev, N. Y.*—May 24, 1899. No. 27766.

Phase Angles.

Phase Angle Measurements. Edwin Place. A report of the writer's investigations in this field, and the conclusions reached. Ill. 3300 w. *Elec Wld & Elec Engr*—May 13, 1899. No. 27572.

Pressure.

An Accurate Method and Apparatus for Measurement of Pressure in Feed Wires Ueber ein Verfahren und einen Apparat zur Fehlerfreien Messung der Speisepunktspannungen in Leitungsnetzen). Dr. J. Teichmüller. A mathematical discussion of the causes of error, and a description of a voltmeter with adjustable resistance to enable accurate measurements to be made. 2500 w. *Elektrotech Zeitschr*—April 6, 1899. No. 27864 B.

POWER APPLICATIONS.

Efficiency.

Efficiency of Small Motors. Alton D. Adams. Considers the character and location of losses in motors under the heads of loss in armature and magnet winding, losses in iron cores and poles, and losses by friction of bearings, commutator and air. 1300 w. *Am Elec*—May, 1899. No. 27483.

Locomotives.

Electric Locomotives. Abstract of a paper by Mr. McMahon read before the Inst. of Elec. Eng. (England). The paper was based on figures obtained over a period of two years of daily working on the City and South London Ry. 2800 w. *Elec Rev, Lond*—May 12, 1899. Serial. 1st part. No. 27714 A.

Mine Plant.

Electric Power Transmission and

Lighting Plant at the "Hollertszug" Mine. (Elektrische Kraftübertragungs und Beleuchtungsanlage der Eisenerzgrube "Hollertszug".) An excellent example of the use of electricity in mine hoisting, pumping, air-compressing and lighting. 2000 w. *Gluckauf*—April 29, 1899. No. 27860 B.

The Application of Electricity for Work in Collieries. Clifford R. Buck. Brief account of current practice in the use of electric power for colliery installations. Ill. 7000 w. *Sch of Mines Quar*—April, 1899. No. 27453 D.

Motors.

The Theory of Asynchronous Motors. (Zur Theorie der Asynchronmotoren.) Julius Heubach. A general graphical study of single and polyphase motors, with diagrams and tables of coefficients for practical use. Two articles, 6000 w. *Elektrotech Zeitschr*—April 27, May 4, 1899. No. 27874 each B.

Propulsion.

Electric Power for Marine Propulsion. Charles T. Child. A discussion of the advantages of electric propulsion for special conditions, such as ferryboats, torpedo boats, etc., where intermittent service or silence and secrecy render steam unsatisfactory. 2500 w. *Engineering Magazine*—June, 1899. No. 27899 B.

TRANSMISSION.

Milan-Paderno.

The Power Transmission and Central Station Plants of the "Societa Generale Italiana Edison di Elettricit " at Milan. Illustrated description of one of the finest and largest installations in Europe. 1800 w. *Elec Rev, N. Y.*—May 10, 1899. No. 27569.

MISCELLANY.

Connecting Tool.

Connecting Tool for High Tension Conductors. (Ableitungs Schraubklemme f r Hochspannungsleitungen.) P. von Kowaleff. An ingenious tool by use of which a wire may be attached to a high-tension conductor without risk to the operator. 800 w. *Elektrotech Zeitschr*—April 6, 1899. No. 27866 B.

Torpedo Steering.

Torpedo Steering by Ether Waves. Illustrates and describes an invention by Walter Jamieson and John Trotter for the wireless control of torpedoes. 1700 w. *Elect'n. Lond*—May 19, 1899. No. 27796 A.

Volta.

The Centenary of Volta's Discovery of the Electric Battery. A brief review of Volta and his time, with illustrations. 2200 w. *Elec Wld & Elec Engr*—May 13, 1899. No. 27571.

GAS ENGINEERING

Acetylene.

Acetylene Gas Accidents. John B. C. Kershaw. A summary of accidents that have come under the writer's notice during the last two years. 1000 w. Elec Rev, Lond—April 28, 1899. No. 27531 A.

Acetylene Gas as a Mine Illuminant. A. Holland. Abstract of an address before the Can. Min. Inst. Reports the use in the Grand Calumet Silver Lead Mine, and states its advantages as a mine illuminant. 1300 w. Ir & Coal Trds Rev—April 28, 1899. No. 27548 A.

Address.

Inaugural Address Before the Institution of Gas Engineers. F. D. Marshall. The address discusses English and Continental methods of gas production, and subjects of interest to gas engineers. 7300 w. Jour Gas Lgt—May 2, 1899. No. 27566 A.

Ammonia.

On the Methods Employed in the Analysis of Commercial Ammonia. A. Lunge and W. Hefer. Reviews methods recently published on this subject. 900 w. Am Gas Lgt Jour—May 8, 1899. No. 27513.

The Determination of Ammonia in Gas Liquor: A Simple Method. Dr. Lubberger. Summary of an article in the *Journal für Gasbeleuchtung*. Describes a method giving data much nearer analytical results than are those obtained by Knubbauch's method. 900 w. Gas Wld—May 20, 1899. No. 27794 A.

Analysis.

Improvements in the Analysis of Gas. On the method adopted by Dr. Otto Pfeiffer, of Magdeburg, and the faults of methods now in use. Ill. 2400 w. Gas Wld—April 29, 1899. No. 27522 A.

Calcium Carbide.

On the Crushing of Raw Materials for the Manufacture of Calcium Carbide. Abstract from the *Zeitschrift für Electrochemie*. Practice has shown that comparatively coarse crushing is better than pulverizing, and this has caused a change in the machinery used, and the manner shown to be most advantageous is given. 1500 w. Elect'n, Lond—May 19, 1899. No. 27798 A.

Carbide Patent.

The Nullification of the Bullier Carbide Patent in Germany. (Zur Nichtigkeits-erklärung des D. R. P.Nr. 77168 Bullier Verfahren- zur Darstellung von Erdalkalicarbid.) Dr. W. Borchers. A review of the decision, with the text of the patent and references to anticipations of the recent carbide patents. Two articles. 7500 w. Zeitschr f Elektrochemie—April 20, May 18, 1899. No. 27880 each G.

Carbonic Oxide.

Water Gas and Other Gases Containing a Large Proportion of Carbonic Oxide. A few of the important facts and theories embodied in the recent report of the committee appointed by the Home Secretary to inquire into their manufacture and use. 4000 w. Prac Engr—May 12, 1899. No. 27711 A.

Carbonization.

A Rotatory Retort and Water Gas Generator. Specifications of an apparatus for producing illuminating gas by the distillation of coal, shale, or carbonaceous tar. Ill. 2000 w. Gas Wld—April 29, 1899. No. 27523 A.

Coal Tar.

Notes on Coal Tar and the Preparation of Its Products. Ernest F. Hooper. Read before the North of England Gas Managers' Assn. Considers coal tar and its constituents, giving a brief historical summary, and how the products are prepared. 4500 w. Jour Gas Lgt—May 2, 1899. No. 27568 A.

Coke Handling.

Coke Handling Plant. T. Holgate. Read before the British Inst. of Gas Engs. A report of the officers' experience, and information gathered in connection with the introduction of a coke handling plant at Halifax. Detailed description of the plant and appliances. Discussion. Ill. 15400 w. Gas Wld—May 6, 1899. No. 27647 A.

Combustion.

The Products of Combustion of Illuminating Gas. Digest of an interesting paper by Prof. Gréhan presented to the Societe d'Encouragement pour l'Industrie Nationale. Gives methods used by the writer in researches. Various types of gas burners were examined. 2700 w. Jour Gas Lgt—April 25, 1899. No. 27479 A.

Distribution.

A Notable Gas Engineering Feat in the City. Describes a unique piece of work made necessary by the construction of the Central London Railway. Ill. 1800 w. Jour Gas Lgt—May 16, 1899. No. 2759 A.

A Note on Distribution. C. C. Carpenter. Read before the British Inst. of Gas Engs. Gives a description of the method adopted by the South Metropolitan Co. for getting the benefit of high pressure in the initial mains. Discussion. 3000 w. Gas Wld—May 6, 1899. No. 27649 A.

We supply copies of these articles. See introductory.

Gasholders.

Large Gasholders in England. Norton H. Humphreys. Considers gasholders about 230 feet in diameter and 150 feet high. 2000 w. *Am Gas Lgt Jour*—May 22, 1899. Serial. 1st part. No. 27703.

Wind Pressure on Buildings and Other Structures. J. O. V. Irminger. Read before the British Inst. of Gas Engs. An interesting paper, showing the bearing of the subject on the construction of gasholders. Ill. 5500 w. *Gas Wld*—May 6, 1899. No. 27651 A.

History.

Notes Upon the Early History of Gas Manufacture. H. C. Slaney. Read before the Brooklyn Engs.' Club. Reviews the history of this industry, its works and accessories. Ill. 3500 w. *Pro Age*—May 15, 1899. No. 27622.

Hydraulic Mains.

The Hydraulic Main and Its Fittings. L. A. Guyatt. Read before the Eastern Gas Mgrs.' Ass'n, England. Illustrates and describes a form of tar-overflow used in the Vauxhall and Bankside works of the South Metropolitan Gas Co. 1700 w. *Gas Engs' Mag*—May 10, 1899. No. 27-793 A.

Mains.

Some Special Features in the Connecting Mains of a Provincial Gas Company's Stations. W. Doig Gibb. Read before the North of England Gas Managers' Assn. Notes refer to the Newcastle works, Gateshead works, the new works, and the North of Tyne governor-house in England. Ill. Discussion. 8300 w. *Jour Gas Lgt*—May 2, 1899. No. 27567 A.

Mantles.

Incandescent Mantles. Vivian B. Lewes. Read before the British Inst. of Gas Engs. Reviews the discovery of the principle of the Welsbach mantle, the improvements, the theories advanced to explain efforts, etc. 7800 w. *Gas Wld*—May 6, 1899. 27652 A.

Nitrogen.

The Direct Estimation of Nitrogen in Gases. J. Kent Smith. Read before the Liverpool Section of the Society of Chem-

ical Industry. Describes a method for the direct estimation of nitrogen in illuminating and other gases without the aid of gas analysis apparatus. 1200 w. *Jour Gas Lgt*—April 25, 1899. No. 27-480 A.

Oil Gas.

The Oil-Gas Plant at Hütteldorf-Hacking. (Die Oelgas-Anstalt in Hütteldorf-Hacking.) Franz Grobben. A plant for the manufacture of oil-gas for use on the Vienna local railway. Both the generating and compressing apparatus are described. 2000 w. *Zeitschr d Oesterr Ing M Arch Ver*—April 21, 1899. No. 27-829 B.

Photometers.

How to Make and Use a Photometer. Arthur J. Rowland. Gives directions for the construction and use. Ill. 3700 w. *Am Elect'n*—May, 1899. No. 27484.

Pipes.

Determining the Size of Gas Pipes. W. Graffton. Directions for determining the size of pipes needed to supply a certain number of lights. 700 w. *Am Gas Lgt Jour*—May 8, 1899. No. 27512.

Some Notes on Purification. A. L. Clarke. Read before the Eastern Cos. Gas Managers' Assn. Notes on hydraulic and foul mains, washing, and dry purification, with discussion. 4400 w. *Gas Wld*—April 22, 1899. No. 27420 A.

Retorts.

Notes on Modern Systems of Retort Heating. G. P. Lewis. Read before the British Inst. of Gas Engs. Deals with the principles of recuperative firing, giving a detailed comparative statement of the points at present under discussion in reference to the use of gaseous fuel in retort settings. Ill. 7500 w. *Gas Wld*—May 6, 1899. No. 27648 A.

Water Gas.

The Practical Working of Carburetted water Gas. Charles F. Botley. Read before the British Inst. of Gas Engs. A practical account of the plant which has been put up at Hastings, the conditions and results of the working. Discussion. 15500 w. *Gas Wld*—May 6, 1899. No. 27-650 A.

MARINE AND NAVAL ENGINEERING

Battleships.

The Old Line of Battleship "Pennsylvania." Illustrated description of this old battleship, launched in 1837, and of Nelson's flagship, the "Victory." 1600 w. *Sci Am*—May 27, 1899. No. 27765.

Boiler Explosion.

See Mechanical Engineering, Steam Engineering.

Cruisers.

Cross-Section of the Diadem. Cross-section of a vessel of the protected-cruiser

type, with description. 1700 w. Engr, London—April 21, 1899. No. 27423 A.

Trials and Experiments Made on H. M. S. Argonaut. John Durston. Read before the Brit. Inst. of Naval Archts. An account of the results of the contract, trials and of experiments made. 3600 w. Trans of Brit Inst of Naval Archts—March, 1899. No. 27600 E.

Destroyers.

Torpedo-Boat Destroyers for Sea Service. James Howden. Read before the Brit. Inst. of Naval Archts. Illustrates and describes designs for making these vessels more effective as sea boats. 4000 w. Trans of Brit Inst of Naval Archts—March, 1899. No. 27599 E.

Gun Fire.

Effect of the Gun Fire of the United States Vessels in the Battle of Manila Bay. John M. Ellicott. Report by the Intelligence Office of the U. S. S. Baltimore, which took part in the action. Ill. 4200 w. Naut Gaz—April 27, 1899. No. 27355.

Ice Breaker.

The Ice Breaking Boat "Ermack." (Le Vapeur Brise-Glace "Ermack.") A general description of the new Russian ice breaker, with plan and sections, and an account of the successful opening of the harbor of Cronstadt. 2000 w. Le Yacht—April 15, 1899. No. 27863 B.

Marine Engines.

Engines Afloat. Part first considers bilge pumps and the means of locating and remedying difficulties. 1800 w. Prac Engr—April 21, 1899. Serial. 1st part. No. 27417 A.

Monitor.

The Old Type of Monitor. William H. Wiley. Remarks of Admiral Bunce, with description of the engines. Ill. 1700 w. Ir Age—May 18, 1899. No. 27654.

Motor Boat.

Motor Boat for Sea Service. Illustrates and describes a sea-going alco-vapor motor boat, designed for short cruises on the exposed coast of Maine and Massachusetts. 350 w. Marine Engng—May, 1899. No. 27474 C.

Repair-Ship.

The Work of the Naval Repair-ship Vulcan. Gardiner C. Sims and W. S. Aldrich. Giving an authoritative account of the equipment and work of the floating machine-shop of the American navy. 6000 w. Engineering Magazine—June, 1899. No. 27891 B.

River Boats.

Our Western Rivers. Part first considers the Mississippi and its tributaries, the commerce and types of craft navigating these streams. Ill. 1800 w. Naut Gaz—May 11, 1899. Serial. 1st part. No. 27588.

Shafting.

Notes on the Manufacture of Shafting for Screw Steamers, with Some Causes of Defects and Failures. E. C. Chaston. Abstract of paper read before the N. E. Coast Inst. of Engs. and Shipbuilders. Aims to prove that about half the defects and failures are due to preventable causes. 1200 w. Mech Wld—April 21, 1899. Serial. 1st part. No. 27413 A.

Shipbuilding.

The Connection Between Mechanical Engineering and Modern Shipbuilding. William H. White. Presidential address before the Inst. of Mech. Engs. Aims to indicate the directions in which shipbuilding and the working of ships have been influenced by mechanical engineering. 2500 w. Engng—April 28, 1899. Serial. 1st part. No. 27541 A.

Steamer.

T.-S. S. "Moskva," for the Russian Volunteer Fleet. Profile and deck plans with description of this twin-screw mail and passenger steamer. 600 w. Engng—May 12, 1899. No. 27724 A.

Steel Construction.

The Arthur Sewall, an American Ship-entire Built of American Steel. Illustrated detailed description with principal dimensions. 1500 w. Marine Engng—May, 1899. No. 27473 C.

Trial Tank.

Influence of the Walls of Trial Tanks Upon the Indications of Current Meters (Einfluss der Wandungen von Versuchscanälen auf die Umlanfwerte Hydrometrische Flügel.) A report of the government hydrographic bureau, showing the precautions necessary for the accurate calibration of current meters. An important contribution to hydrodynamics. 10,000 w. 2 plates. Oestess Monatschr f d Oeffent Baudienst—May, 1899. No. 27827 D.

Water Tube.

Babcock & Wilcox Water-Tube Boilers in H. M. S. "Sheldrake." Particulars regarding the installation and tests. Ill. 2400 w. Steamship—May, 1899. No. 27521 A.

Yacht.

The New Royal Yacht. An illustrated description of Her Majesty's New Yacht—Victoria and Albert—with an interesting account of the launching. 4000 w. Engng—May 12, 1899. No. 27723 A.

Yarrow Boiler.

A Tale of a Yarrow Boiler. Illustrated description of the condition of a boiler on a minor vessel of the American navy, after a service of some months on the Cuban blockade. It had been in use thirteen months. 1400 w. Locomotive—March, 1899. No. 27550.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Advantages.

Some Sanitary and Allied Advantages Attending the Introduction and Use of Motor Vehicles. E. Shrapnell Smith. Full paper as read before the Municipal and County Engs. Deals with improvements in sanitary conditions and reduction of cost. 1200 w. Jour San Inst—April, 1899. No. 27468 F.

Early Designs.

Some Early Forms of the Automobile. Illustrated historical account of early mechanical road carriages, dating back to 1763. 1300 w. Sci Am—May 13, 1899. No. 27590.

Electric Vehicles.

American Types of Electric Motor Vehicles. Thomas B. Booth. Part first gives illustrated descriptions of the Columbia automobiles, with comments on the development and progress of this industry. 5000 w. Elec Wld & Elec Eng—May 6, 1899. Serial. 1st part. No. 27492.

Hub.

A Rubber Cushioned Hub. Illustrated description of an invention for reducing the vibration of vehicles, adapted for motor vehicles and cycles. 600 w. Engr. Lond—April 28, 1899. No. 27538 A.

Motor Car.

A Gasoline Motor Car. Illustrated description of a car built by the Jewett Car Co., of Jewett, O. 1000 w. R R Gaz—May 5, 1899. No. 27495.

Operating Cost.

The Cost of Working an Automobile. Dr. Calbet, in *La France Automobile*. Statement of expenses for the year 1898, with comments. 1000 w. Automotor—May 15, 1899. No. 27744 A.

Paris Cabs.

The Central Station of the Electric Cab System of Paris. (Station Centrale de Fiacres Electriques de la Compagnie Generale des Voitures à Paris.) E. Campagne. Giving views of buildings, cabs, generating plant, accumulator room, etc., and a general account of the work of the company. 3500 w. 1 plate. Génie Civil—April 15, 1899. No. 27800 D.

Petroleum Vehicles.

Petroleum Motor Vehicles. James D. Roots. Excerpt of paper read before the Soc. of Engs. Gives illustrated descriptions of vehicles constructed since 1885, and the progress made. 7000 w. Automotor—May 15, 1899. No. 27745 A.

Regulators.

Speed Regulators for Petroleum Engines. Anthony G. New. Considers the method of regulating the speed of the engine by varying the time of ignition, and compares in with the tube-ignition engine. fitted with hit-and-miss governor. 1000 w. Automotor—May 15, 1899. No. 27747 A.

Steam Bicycle.

S. H. Roper's Steam Bicycle. R. I. Clegg. Illustrated description, with an account of the work of the inventor. 1500 w. Am Mach—May 18, 1899. No. 27640.

Wheels.

Stresses in Driving Wheels. H. E. Wimperis. Wooden wheels are mainly considered. 1000 w. Automotor—May 15, 1899. No. 27746 A.

HYDRAULICS.

Power Distribution.

Hydraulic Transmission and Distribution of Power. E. B. Ellington. The concluding paper is devoted to the practical questions connected with the delivery and utilization of hydraulic power, including motors and tools operated directly by hydraulic pressure. 3500 w. Engineering Magazine—June, 1899. No. 27893 B.

Turbine.

The Efficiency of the Screw Turbine. (Die Nutzleistung der Schraubenturbine.) M. Möller. A mathematical discussion showing the conditions under which the highest efficiency may be attained. 2000 w. Zeitschr d Ver Deutscher Ing—May 13, 1899. No. 27824 D.

Water Wheels.

Water Wheels, Ancient and Modern. Illustrates and describes primitive pieces of apparatus for utilizing the power of water. Part first deals with the ancient methods. 2000 w. Fire & Water—May 13, 1899. Serial. 1st part. No. 27626.

MACHINE WORKS AND FOUNDRIES.

Accidents.

The Prevention of Accidents in Industrial Concerns. L. Charles Wallach. Considers the importance of giving attention to this subject, the primary causes of accidents, safety guards and appliances, etc. 3500 w. Mech Wld—May 12, 1899. No. 27707 A.

Air Furnaces.

Reverberatory Air Furnaces; Malleable Practice. E. C. Wheeler. Considers these furnaces and claims that automatic stock-

ing will solve the combustion question and cure all existing defects. 3500 w. Foundry—May, 1899. No. 27704.

Bar Iron.

Suggested Improvements in the Manufacture of Bar Iron. Samuel Peters. Read before the Engs. Soc. of W. Penna. Brief description of a method which the writer thinks will give desirable results. 2700 w. Am. Mfr & Ir Wld—May 26, 1899. No. 27781.

Blacksmith Shops.

Modern Blacksmith Shops. S. H. Stupa-koff. An account of the progress and changes, the tools used, etc. 2500 w. Ir Trd Rev—May 11, 1899. No. 27591.

Brass.

Light Brass Founding. C. Vickers. Suggestions for this class of work. 1600 w. Am Mach—May 11, 1899. No. 27565.

Brasses.

Some Points About Making Car Brasses. Views of Mr. James Swan on the subject of the making and care of journal brasses. 900 w. Ry Mas Mech—May, 1899. No. 27553 A.

Bridge Shops.

Notable New Bridge-Shop Machines. Illustrated description of modern tools and the power application used. 2800 w. Bridges—May, 1899. No. 27684 C.

Bronze.

Phosphor Bronze. A Description of Its Characteristics and Methods of Manufacture. L. L. Smith. Deals with the composition and specifications, action of phosphorus, foundry treatment, etc. 1900 w. Am Eng & R R Jour—May, 1899. No. 27394 C.

Burnishing.

Burnished Finish for Journals and Plain Surfaces. On the advantages of the roller finish and the practice of various roads. Ill. 1800 w. Am Eng & R R Jour—May, 1899. No. 27397 C.

Cast Iron.

Theories and Facts Relating to Cast-Iron and Steel. Bertrand S. Summers. Abstract of a paper read before the British Iron and Steel Inst. Discusses the physics of cast-iron and steel, and the possibly important action of Prof. Ledebur's graphitic temper-carbon. 3200 w. Ir & Coal Trds Rev—May 12, 1899. No. 27719 A.

Charges.

Shop and General Establishment Charges in Engineering Works and Their Relation to Cost and Estimates. William Edward Cowens. Read before the Northeast Coast Inst. of Engs. and Shipbuilders. A suggestive paper written from the works manager's standpoint. 2800 w. Ind & Ir—May 5, 1899. No. 27602 A.

Clutch.

A Combined Friction and Positive Clutch. Illustrated description of a clutch in successful use in Germany and England, and recently patented in the United States by Jacob Missong. It possesses new and interesting features. 700 w. Am Mach—May 4, 1899. No. 27471.

Coining.

The Making of Coining Dies. (La Fabrication des Monnaies.) Illustrating and describing the machine used at the Paris Mint for reproducing, on a reduced scale, the designs for dies, for coins, medals, etc. 1200 w. Genie Civil—April 15, 1899. No. 27801 D.

Coke.

Foundry Coke. Walter J. May. Discusses the question of good foundry coke. 1000 w. Prac Engr—May 5, 1899. No. 27631 A.

Cupolas.

Cupola Capacity—Tuyere Area and Arrangement—Blast Pressure—Charging Cupolas—Design for a Cupola. L. C. Jewett. Briefly considers the subjects named. 1300 w. Am Mach—May 4, 1899. No. 27470.

Cylinders.

Making Corliss Cylinders. Joseph Horner. illustrated description of the methods employed in construction. 1400 w. Mech Wld—April 28, 1899. Serial. 1st part. No. 27552 A.

Dies.

Cast Iron Dies. R. I. Clegg. Particulars concerning the use and capacity, the molding and pattern making in getting out the die and tools. Ill. 1300 w. Am Mach—May 11, 1899. No. 27564.

Making a Punch and Die in a High-Pressure Machine Shop. A. H. Cleaves. Illustrated description. 500 w. Am Mach—May 25, 1899. No. 27753.

Etching.

Acid Blast Process for Etching. Louis Edward Levy. Abstract of a paper on a new method of etching. Ill. 2500 w. Jour Fr Inst—May, 1899. No. 27500 D.

Foundry Irons.

Blast Furnace Compared with Cupola Practice. Edgar S. Cook. Read before the Foundrymen's Assn., Philadelphia. Discusses casting machines, fracture, sandy iron, temperature and sulphur, atmospheric moisture, chill, sampling, etc. 6300 w. Ir Age—May 11, 1899. No. 27563.

Foundry Practice.

Foundry Practice at the Close of the 19th Century. (Der Giessereibetrieb am Ende des Neunzehnten Jahrhunderts.) A Ledebur. A general review of the development of foundry practice during the

latter half of the century, with a number of fine views and plans of the foundries of Borsig, at Berlin, and Sulzer Bros. at Winterthur. 12,000 w. 7 plates. Zeitschr d Ver Deutscher Ing—April 22, 1899. No. 27816 D.

Handling Materials.

Handling Materials in a Foundry. W. J. Keep. Abstract of a paper presented at the Pittsburg meeting of the Am. Found. Assn. Illustrates and describes the methods in use at the works of the Michigan Stove Co., Detroit Mich. 4000 w. Ir Age—May 25, 1899. No. 27748.

Machine Design.

Speeds and Feeds of Machine Tools. C. C. Stutz. Suggestions for machine tool designers, with explanation of a simple and quick method for obtaining a geometrical progression of speeds and feeds in machine drives. Ill. 3500 w. Mach. N. Y.—May, 1899. No. 27409.

Machine Tools.

The Productive Capacity of Machine Tools. (La Production des Machines-Outils.) MM. Huillier & Fremont. A valuable paper, giving the results of dynamometric tests upon various tools, showing the power required for the production of a given result. 8000 w. Bull de la Soc. d'Encour—April, 1899. No. 27809 G.

Paper Mill.

American Wood Cutting and Pulping Mills. (Amerikanische Schneidemühle und Entrindungsanlage.) F. Stallmaier. A description of the arrangement of mills for grinding wood into paper-pulp as practiced in Canada and the United States. 1000 w. Zeitschr d Ver Deutscher Ing—April 22, 1899. No. 27818 D.

Pig Iron.

The Position of Pig Iron. Editorial discussion of the present situation, which threatens a famine of pig-iron supplies. 2500 w. Engr, Lond—April 21, 1899. No. 27425 A.

Precision Machinery.

Professor W. S. Roger's Precision Lathe. An account of the methods used in this machine, which was destroyed by fire, and whose inventor is dead, with editorial on the call for this class of machinery. 2500 w. Am Mach—May 25, 1899. No. 27751.

Printing Presses.

Some Printing Press Movements. Franklin Sweet. Describes the vital movements of a press showing how difficult are some of the problems. Ill. 3800 w. Wis Engr—May, 1899. No. 27662 D.

Projectiles.

Making of Projectiles. J. A. Murphy. Describes the making of shells and gives

hints on the construction of patterns, core boxes, flasks, etc. 1200 w. Foundry—May, 1899. No. 27705.

Repair-Ship.

See Marine and Naval Engineering.

Screw-Cutting.

"Catching the Thread" in Screw-Cutting After Running the Carriage Back by Hand. Explains the principles of a device used by the R. K. Le Blond Machine Co., of Cincinnati. Ill. 800 w. Mach. N. Y.—May, 1899. No. 27411.

Shafting.

See Marine and Naval Engineering.

Shafts.

Hollow-Bored Shafts as Made by the Cast Steel Works of Fried. Krupp, Germany. George H. Bryant. Illustrated description of the processes used, a statement of the advantages of hollow shafts, and information concerning material, etc. 3500 w. Wis Engr—May, 1899. No. 27658 D.

Shops.

The Shops of the Landis Tool Company. Illustrated description. 1400 w. Am Mach—May 25, 1899. Serial. 1st part. No. 27752.

Tools.

Machine Tools. Ewart C. Amos. Abstracted from a paper read before the Soc. of Eng. Considers the distinctive features of modern tools and compares British and American tools. 3300 w. Mech Wld—April 21, 1899. No. 27414 A.

Wages.

Methods of Remunerating Labor. P. J. Darlington. A critical comparison of the piece-work, piece-rate, and premium systems of remunerating labor, setting forth the advantages of the piece-rate system. 4000 w. Engineering Magazine—June, 1899. No. 27896 B.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. Mr. Orcutt's sixth paper compares the various systems used in Europe and America with respect to the important questions of output, price and quality. 4000 w. Engineering Magazine—June, 1899. No. 27892 B.

Wrenches.

Proportions for Wrenches. Information upon the subject of open-end wrenches. Ill. 900 w. Mach, N. Y.—May, 1899. No. 27410.

MATERIALS OF CONSTRUCTION.

Hardening.

The Stresses in Large Sections of Hardened Steel. (Ueber Spannungen im Gehärteten Stahle Grosseren Ouerschnitts.) Otto Thallner. A discussion

of the internal stresses produced by the molecular changes consequent upon hardening, with illustrations and data from many experiments. 3500 w. Stahl und Eisen—April 1, 1899. No. 27851 D.

Overstrain.

On the Recovery of Iron from Overstrain. James Muir. Such recovery is known to be affected by time; and a summary of experiments is given showing the effect of moderate temperature, mechanical vibration, and magnetic agitation, giving compression tests illustrating the recovery. 1300 w. Engr, Lond—April 28, 1899. No. 27539 A.

Samples.

The Utility of Chemically Standardized Iron Samples. Albert W. Smith. Read before the Am. Found. Assn. Discusses the circumstances that influence the manner of combination of the elements in chemical composition. 1500 w. Ir Age—May 25, 1899. No. 27749.

Specification.

Notes on Specifications for Cast Iron Water and Gas Pipes. C. A. Meissner. Read before the Min. Soc. of Nova Scotia. Calls attention to points in the average specification that seem very unnecessary, and submits a concise specification covering all points. 2200 w. Can Min Rev—April 29, 1899. No. 27408 B.

Strains.

Instruments for Measuring Small Torsional Strains. E. G. Coker. Read before the British Assn. for the Adv. of Science. Illustrates and describes two arrangements of apparatus intended for use in engineering laboratories and testing houses for measuring such strains, and for the determination of the modulus of rigidity. 1700 w. Can Engr—May, 1899. No. 27557.

Testing.

Standards for Testing Cast Iron. A report by the committee of the A. F. A., on the progress of cast iron. 3300 w. Ir Trd Rev—May 18, 1899. No. 27667.

POWER AND TRANSMISSION.

Belt Dressing.

A New Belt Dressing. Extracts from a report of R. C. Carpenter in regard to tests recently made of a new dressing made by the Cling-Surface Manufacturing Co., of Buffalo, to determine the effect of running with and without the preparation under various conditions of loading. 900 w. R R Gaz—May 5, 1899. No. 27496.

Coal Handling.

Notes on Coal Handling Machinery. Discusses correct designs in bearings, tension, the belt, power of the engine, fixing pipes to storage tanks, etc. Ill. 2000

w. Am Mfr & Ir Wld—April 28, 1899. No. 27386.

Compressed Air.

Economy of Compressed Air Power Transmission. William O. Webber. On the possibilities of this method of storing and converting energy, and the cost of development. 1100 w. Compressed Air—May, 1899. No. 27551.

Windmills and Compressed Air. Frank Richards. Considers a proposition to pump air and store it for power, showing that the scheme is not practical. 1200 w. Am Mach—May 18, 1899. No. 27641.

Lifting Machinery.

Some Recent Improvements in Cranes and Lifting Machinery. Edward C. R. Marks. Part first deals with rope and chain pulley blocks, giving illustrations. 1200 w. Prac Engr—April 21, 1899. Serial. 1st part. No. 27416 A.

Power Calculations.

The Calculation of Power. W. H. Wakeman. Points out errors in rules used and explains why they are errors. 2200 w. Mod Mach—May, 1899. No. 27477.

Power Gas.

The Application of Blast Furnace Gases for Operating Gas Engines. (Die Verwendung der Hochofengichtgase zum Betriebe von Gasmotoren.) E. Meyer. A general examination of the applicability of furnace gases for motive power, and details of trials made with blast furnace gas upon a 60 h.p. motor at the Differdingen furnaces in Luxemburg. Two articles, 10-000 w. Zeitschr d Ver Deutscher Ing—April 22 and 29, 1899. No. 27817 each D.

Power Plant.

The James River, Va., Water-Power Development. William Todd. Illustrates and describes the plans of a work now in progress. 1800 w. Elec Wld & Elec Eng—May 6, 1899. No. 27491.

The Proposed Power Plants in the Wäggithal and on the Etzel. (Die Projektirten Kraftanlagen in Wäggithal und am Etzel.) With a map and description of these proposed plants near Zurich, by which more than 80,000 h.p. will be secured. Schweizerische Bauzeitung—April 22, 1899. No. 27834 B.

Shafting.

See Marine and Naval Engineering.

Shafts.

See Machine Works and Foundries.

SPECIAL MOTORS.

Diesel Motor.

The Diesel Motor. Rudolph Diesel. Translation of a report in the *Zeitschrift des Vereines Deutscher Ingenieur*. Gives illustrations of recent motors and an account of experiments with various fuels.

1800 w. Pro Age—May 1, 1899. Serial. 1st part. No. 27384.

Gas Engines.

A Simple Gas Engine. Illustrates and describes an arrangement designed by Harry J. Perkins. 600 w. Am Mach—May 4, 1899. No. 27472.

A 650-H.P. Gas Engine Direct Connected to a 520 K.W. Electric Generator. Brief illustrated description of this Westinghouse engine. 700 w. Engs News—May 4, 1899. No. 27465.

Some Suggestions as to the Care and Management of Gas Engines. E. C. Hathaway. General suggestions for their operation and care. 1600 w. Am Gas Lgt Jour—May 8, 1899. No. 27514.

The New Era Gas Engine. B. A. Illustrates and describes this engine. 800 w. Am Mach—May 18, 1899. No. 27642.

Windmills.

Electric Power from Windmills. C. L. Crandall. The substance of this paper was presented at the Boston meeting of the Am. Assn., for the Adv. of Science. Requests for more information led to the preparation of this paper, which gives the lamp hours a day available for electric lighting from a storage battery plant driven by a 12-foot aeromotor. 1200 w. R R Gaz—May 5, 1899. No. 27498.

STEAM ENGINEERING.

Balancing.

A Curious Problem in Balancing. Charles P. Paulding. Explains the problem and the graphical construction showing how satisfactory is this method of computation. 1300 w. Am Mach—May 4, 1899. No. 27469.

The Balancing of Engines, with Special Reference to Marine Work. W. E. Dalby. Read before the British Inst. of Naval Archts. Explains and illustrates a semi-graphical method of treating balancing problems in a direct and simple manner. Also discusses the proper treatment of the connecting rod. Ill. 5000 w. Engng—April 21, 1899. Serial. 1st part. No. 27434 A.

Blowing Engine.

Blowing Engine at the Krompach Works. Illustrates and describes engines built for blast-furnace use, giving the leading dimensions. 500 w. Engr, Lond—April 21, 1899. No. 27426 A.

Blowing Engines for Blast Furnaces. (Hochofen-Gebläsemaschine.) Fritz Lamey. An illustrated description of the powerful compound blowing engines built by the Elsass Machine Works at Mülhausen for the Krupp Works at Rheinhausen; with details, and sectional elevation. 2000 w. 1 plate. Zeitschr d Ver Deutscher Ing—April 15, 1899. No. 27814 D.

Boiler Explosions.

The Explosions of the Boilers of H. M. S. "Terrible." Editorial on the explosions of this vessel's boilers, suggesting that the ship be reboilered with some other type of water tube than the Belleville. 1400 w. Engr Gaz—May, 1899. No. 27534 A.

Chimney.

The Great Chimney of the La Bourdonnais Power House on the Champ-de-Mars. (La Cheminée Monumentale de l'Usine La Bourdonnais au Champ-de-Mars.) Ch. Dantin. An account of the design and construction of the great chimney for the power-house of the Exposition of 1900, with elevation and section, and photographs of the excavations for the foundation. 2500 w. Génie Civil—May 6, 1899. No. 27804 D.

Combustion.

Gas Analysis and Furnace Economy. A. Bement. Showing the value of an accurate knowledge of the state of combustion. 2000 w. Mod Mach—May, 1899. No. 27475.

Condenser.

Condensation in Steam Engines. From *La Nature*. An improved form of ejector condenser adapted to use the same condensing water repeatedly. 1000 w. Sci Am Sup—May 20, 1899. No. 27644.

Evaporative Condensers. Harry G. V. Oldham. From a paper read before the Inst. of Mech. Engs., England. Illustrates and describes the methods of Theisen, Wright, Fraser and Ledward. 5500 w. Col Guard—April 28, 1899. No. 27547 A.

Cornish Engine.

Cornish Engine, Basset Minis. Illustrates and describes a compound, high-pressure Cornish engine, which has been recently erected at Cornwall, with an account of the trial. 1000 w. Engr, Lond—May 12, 1899. No. 27725 A.

Economy.

Steam Boiler Economy. William Kent. Considers especially the heating value of different coals, with three points bearing on economy. 5400 w. Sib Jour of Engng—May, 1899. No. 27761 C.

Engines.

Compound and Condensing Engines. Alfred Siebert. Discusses when it is advisable to condense and when to compound, and other related subjects. 2800 w. Ice & Refrig—May, 1899. No. 27456 C.

Economy of Multiple Expansion Engines. William S. Aldrich. Considers the effects of changes of load, systems of installations, speed regulations, etc., in relation to the economical working. 2700 w. Am Elect'n—May, 1899. Serial. 1st part. No. 27482.

The New 2000-Horse-Power Engines and Alternator at Deptford. Illustrated detailed description. 1700 w. Engr, Lond—April 21, 1899. No. 27424 A.

Vertical Steam Engines. (Stehende Dampfmaschinen.) G. Marx. A very full review of the more recent designs of the leading German builders, with numerous illustrations. 6000 w. Zeitschr d Ver Deutscher Ing—May 13, 1899. No. 27823 D.

Engine Design.

The Application of Combined Diagrams in the Design of Compound Engines. (Die Mittel zur Erzielung des Gewünschten Diagramm-verlaufes bei der Konstruktion des Diagramms einer Verbund-dampfmaschine.) H. Lynen. Showing the method of applying the combination of ideal indicator diagrams to the proportioning of compound engines. 4500 w. Zeitschr d Ver Deutscher Ing—April 29, 1899. No. 27819 D.

Engine Test.

Test of a Nordberg Pumping Engine in the Pumping Station of the Pennsylvania Water Company, at Wildwood Station, Pittsburg, Pa. R. C. Carpenter. Describes the engine and tests, giving the general results. 4200 w. Sib Jour of Engng—April, 1899. No. 27352 C.

Expansion.

Economy as Effected by Expansion. C. H. Brustlein. Showing the effect of the variation of the ratio of expansion, upon the ideal engine, and the modifications introduced by the imperfections of the real engine. 2000 w. Sib Jour of Engng—April, 1899. No. 27354 C.

Flow.

The Flow of Steam in Locomotive Cylinders. (Die Dampfeinströmung in die Cylinder der Lokomotiven.) A mathematical discussion by Inspector Leitzmann, with curves constructed for various pressures and port openings. 3000 w. Glasers Annalen—April 15, 1899. No. 27848 D.

Fuel.

Adapting the Coal to the Grates, Draught, etc., and Vice Versa. H. H. Kelley. Considers the economy and advantage of selecting coal suited to the type of boiler, draught, and grate-bars used. 2700 w. Engr, U. S. A—May 15, 1899. No. 27628.

Furnace.

A Test of the Murphy Automatic Furnace. A. W. Richter. A brief illustrated description of the furnace and test made, giving data and results. 1700 w. Sib Jour of Engng—April, 1899. No. 27353 C.

Generators.

Improvements in Steam Generators. (Dispositif Applicable aux Générateurs de

Vapeur.) An illustrated description of a steam generating system in which the water is supplied to the boiler in direct proportion to the consumption of steam. 2000 w. Revue Technique—April 25, 1899. No. 27808 D.

Governing.

An Electric Governor. (Régulateur Electrique.) Ch. Gruet. An illustrated description of a system by which the speed of the steam engine is governed directly from the dynamo instead of using centrifugal force. 1500 w. Revue Technique—May 10, 1899. No. 27813 D.

The Controlling Power of Governors. Translated from *Zeitschrift des Vereines Deutscher Ingenieure*. Remarks explanatory of the forces in the governor, and their action. Mathematical determination of the power available. 3500 w. Mech Wld—May 12, 1899. No. 27708 A.

The Siemens' Regulating Principle and the American Inertia Governors. (Das Siemenssche Regulirprinzip und die Amerikanischen "Inertie-Regulatoren.") A. Stodola. An exhaustive examination of the inertia principle as applied to steam engine governors, showing the anticipation of the modern governors by the Siemens' governor of 1845. Serial. Part I. 8000 w. Zeitschr d Ver Deutscher Ing—May 6, 1899. No. 27820 D.

Heat-Absorption.

Experiments on the Heat Absorption of Water. An account of experiments carried out by Mr. G. Halliday in the Inst. of Marine Engs. (England), to ascertain the heat absorptive power of water at different temperatures and different ratio of velocity across the surfaces. 1500 w. Engr, Lond—May 12, 1899. No. 27726 A.

Indicator.

Some Uses of the Steam Engine Indicator. Edward F. Miller. Read before the New England Ry. Club. Discusses the use in setting valves and in determining some defects. Ill. 2500 w. R R Gaz—May 26, 1899. No. 27770.

Marine Engines.

See Marine and Naval Engineering.

Meter.

Apparatus for Measuring Steam. (Dampfiness-Apparate.) An illustrated description of the Lindenheim steam meter, in which the induced flow of steam in a nozzle is used to measure the volume passing. 2000 w. Gesundheits-Ingenieur—April 15, 1899. No. 27855 B.

Mill Engines.

Rolling-Mill Engines. (Motoren zum Antrieb der Walzenstrassen.) C. Kiesselbach. A discussion of the difficult conditions of operation in rolling-mill practice, together with plan and elevation of tan-

dem compound engines designed for such service. Serial. Part 1. 4000 w. Zeitschr d Ver Deutscher Ing—May 13, 1899. No. 27826 D.

Smoke.

Smoke Consumption and Economy of Fuel. Describes the process of Paul Cornelius for the consumption of low-grade fuels, as exhibited in an installation in Berlin, and at Guben, reporting results and tests. 1500 w. U. S. Cons Repts, No. 431.—May 20, 1899. No. 27686 D.

Steam Consumption.

Steam Consumption of Auxiliary Engines in Warships. Editorial noting some of the machinery difficulties in connection with higher pressures and the efforts being made to overcome them. 3000 w. Engng—April 21, 1899. No. 27433 A.

Steam Turbine.

The Theory of the Steam Turbine. (Theorie der Dampf-Turbinen.) A. Fliegner. A thorough mathematical discussion of the subject, showing the difference between pressure and reaction turbines, and the conditions which conduce to the highest efficiency. Five articles. 7500 w. Schweizerische Bauzeitung—March 25, 31, April 15, 29, May 6, 1899. No. 27831 each B.

Stoker.

Smokeless Firing with Inclined Grate. (Rauchfreie Verstellbare Schrägfeuerung.) H. Karft. An illustrated description of an improved stoker by use of which smokeless combustion may be attained. 2000 w. Zeitschr d Ver Deutscher Ing—May 6, 1899. No. 27822 D.

Superheating.

The Production and Application of Super-heated Steam. (Der Ueberhitzte Wasserdampf seine Erzeugung und Verwendung.) H. Hoff. With many illustrations of the latest designs of successful superheaters and engines for use with superheated steam. 4000 w. Stahl und Eisen—April 15, 1899. No. 27854 D.

Triple-Expansion.

Wigzell's Triple-Expansion Engine. Illustrated description. 800 w. Engng—May 5, 1899. No. 27614 A.

Water Tube.

See Marine and Naval Engineering.

Yarrow Boiler.

See Marine and Naval Engineering.

MISCELLANY.

Address.

The Development in Technical Industry During the Past Fifty Years. (Zur Entwicklung der Technischen Wissenschaften und Künste in den Letzten Fünfzig Jahren.) Anton Rücker. The memorial address delivered at the fiftieth anniversary

of the Austrian Society of Engineers and Architects reviewing the progress of the half-century. 10,000 w. Zeitschr d Oester Ing w Arch Ver—May 12, 1899. No. 27830 B.

Bicycles.

The Efficiency of the Bicycle. Robert H. Fernald. A study of the bicycle as a machine, calling attention to interesting points in connection with its efficiency. Ill. 2500 w. Jour Assn of Engng Socs—March, 1899. No. 27381 C.

The Folding Military Bicycle. From *La Nature*. Particulars and illustrations of recent improvements in this machine. 900 w. Sci Am Sup—May 20, 1899. No. 27646.

Gun Explosion.

High Explosives and Big Guns. Editorial on the explosion at the Sandy Hook testing grounds and the behavior of smokeless powder. 1900 w. Ind & Ir—April 28, 1899. No. 27535 A.

Hose.

The Evolution of Fire Hose and Circular Hose Weaving. Gives the historical account of the hose manufacture in the United States. 1500 w. Ind Rub Wld—May 1, 1899. Serial. 1st part. No. 27499 D.

Japan.

The Industrial Situation in Japan. Lamar Lyndon. Devoted especially to Japan as a machinery market and discussing the national characteristics of the people considered as machinery buyers and makers. 3000 w. Engineering Magazine—June, 1899. No. 27898 B.

Liquid Air.

Liquid Air and the Power Required to Produce It. A. H. Neureuther. Describes the usual methods employed to produce liquid air, and gives a statement relating to the power required, with discussion of the amount of work theoretically possible to get from liquid air. Ill. 2700 w. St Ry Rev—May 15, 1899. No. 27733 C.

Liquid Air. Ira Remsen. Explains the method employed in its production, gives an account of some of its properties, and indicates some of the uses to which it may be applied. 5300 w. Ap Pop Sci M—May, 1899. No. 27350 D.

Mr. Tripler and Liquid Air. Madison Cooper. An examination of the claims made for the Tripler process, and a discussion of the probable limitations in the application of liquid air to engineering purposes. 2300 w. Mod Mach—May, 1899. No. 27476.

Power from Liquid Air. A criticism of statements credited to Mr. Tripler, and reported in *McClure's Magazine*. Also remarks on views of W. C. Peckham. Ill. 3600 w. Power—May, 1899. No. 27369.

MINING AND METALLURGY

COAL AND COKE.

Belgium.

Special Features at the Aiseau-Presles Colliery, Belgium. M. J. Collin. Particulars from the paper presented to the Assn. des Ingenieurs de Liege. Describes the breakage, overhead haulage by wire tramway, the adoption of sheer legs for the principal winding shaft, and the emergency hauling engine. 1800 w. Col Guard—May 5, 1899. No. 27609 A.

British Coal.

Our Coal Supplies. T. Forster Brown. A discussion of the problems that must be solved by Great Britain in the near future, especially as regards increase of cost. Discussion. 9800 w. Jour Soc of Arts—April 28, 1899. No. 27520 A.

Burning Mines.

The Burning Mines of Summit Hill. W. C. Morganroth. The origin of the fire and the conditions which have rendered efforts to extinguish it ineffectual. 3500 w. Mines & Min—May, 1899. No. 27437 C.

Carboniferous Beds.

The Correlation of the British and European Carboniferous Beds. Dr. Wheelton Hind. Address delivered before the Manchester Geological Soc. Discusses the question of the correlation of the beds below the millstone grit. 3500 w. Col Guard—April 21, 1899. Serial. 1st part. No. 27428 A.

Coke.

See Mechanical Engineering, Machine Works and Foundries.

Coking.

The Manufacturing of Short Coke. States some of its advantages and the principles on which its formation depends. 1300 w. Mines & Min—May, 1899. No. 27446 C.

The Von Bauer Coking Plant. Julius Elsner in *Stahl und Eisen*. Illustrates and describes the system and method of working, giving a comparison of results. 1600 w. Col Guard—April 28, 1899. No. 27546 A.

Colonial Mines.

Coal Mining in the Colonies. Harrison F. Bulman. A summary of the present condition and extent of coal mining in Canada, Australia and New Zealand. 3000 w. Col Guard—April 28, 1899. No. 27542 A.

Counterpoise.

Winding Rope Counterpoise at a Prussian Colliery. Oberbergrath Leybold, in *Zeitschrift für Berg- Hütten- und Salz-*

nenwesen. Illustrates and describes an appliance which has been in use for some years and is considered satisfactory. 1800 w. Col Guard—April 28, 1899. No. 27543 A.

Head Gears.

Colliery Head Gears—Past and Present. Illustrates and describes the radical changes in this feature of colliery equipment, beginning with the simple device used in early days of coal mining. 900 w. Ir & Coal Trds Rev—April 21, 1899. Serial. 1st part. No. 27421 A.

Labor Saving.

Labor-Saving Devices in Use at a Pennsylvania Anthracite Mine. L. C. Morgenroth. Calls attention to the importance of the details in mining, giving examples of ingenious devices used in a mine recently visited. Ill. 2000 w. Eng & Min Jour—May 13, 1899. Serial. 1st part. No. 27629.

Long Haulage.

The Longest Mine-Haulage. F. Z. Schallenberg. An account of a visit to the Keeling coal mine, near Pittsburg. 1100 w. Trans Am Inst of Min Engs—Feb., 1899. No. 27346 D.

Micro-Organisms.

Micro-Organisms of Coal. B. Renault, in *Naturwissen Schliche Rundschau*. A brief account of investigations. 1200 w. Col Guard—May 5, 1899. No. 27607 A.

Mine Flooding.

New Method of Mine Flooding. Illustrated description of the method adopted by the Pennsylvania Coal Company for subduing a fire in their No. 6 shaft. 900 w. Mines & Min—May, 1899. No. 27441 C.

Oven.

The Von Bauer Coke Oven. (Koksöfen von Dr. von Bauer.) Julius Elsner. A fully illustrated description of the von Bauer ovens as installed in the Krupp works at Hannover. 2500 w. Stahl und Eisen—April 15, 1899. No. 27853 D.

Production.

Coal Production of the Principal Countries of the World. Statistics from the annual statement of the British Board of Trade. 2200 w. Col Guard—May 12, 1899. No. 27720 A.

Scotch Coals.

Chemical Notes on Scotch Coals. W. C. Anderson. Abstracted by the *Journal of the Soc. of Chem. Ind.* from the Proceedings of the Glasgow Philosophical Soc. Considers the varieties, the cak-

ing power, oxidation, etc. 2000 w. *Prac-Engr*—April 28, 1899. No. 27532 A.

Shaft Sinking.

Sinking Shafts Through Quicksand at Bascoup Colliery, Belgium. Edward Briart. From a communication to the Société des Ingenieurs des Mines du Hainaut. Describes and illustrates the methods adopted. Notwithstanding serious difficulties, the work was satisfactorily carried out. 3000 w. *Col Guard*—April 21, 1899. No. 27429 A.

Sinking the Hugo Shaft Near Holten. Oeberbergrath Selbach, in *Zeitschrift für Berg-Hütten-und Salineenwesen*. An account of a difficult piece of work followed by disaster which ruined the labor of three years and incurred a loss of some £37,000. Ill. 1400 w. *Col Guard*—May 5, 1899. No. 27608 A.

Sizing.

The Effect of Sizing on the Removal of Sulphur from Coal by Washing. Charles C. Upham. On the importance of the finer crushing of coal before washing, with suggestions, observations and experiments. 1400 w. *Am. Gas Lgt Jour*—May 8, 1899. No. 27515.

Utah.

Coal Mines of Utah and Coal Mining in Utah Fields. Don Maguire. Information in regard to the deposits and their quality, with a history of the early use of coal in the State, and a description of the present development of the industry at the mines of Scofield, Castle Gate, etc. Ill. 2700 w. *Mines & Min*—May, 1899. No. 27435 C.

West Virginia.

The Thacker Coal Field of West Virginia. Andrew Roy. A description of the formations and the extent and manner of their development. 1200 w. *Mines & Min*—May, 1899. No. 27445 C.

COPPER.

America.

American Copper-Mining. Editorial on the various sources of the American supply, and some comment on the copper combine. 2500 w. *Engng*—May 5, 1899. No. 27615 A.

Arizona.

The Copper Mines and Districts of Arizona. G. Frank Judson. Describes the geological formation of the country and the deposits, and mines in operation. 3300 w. *Min Rept*—May 8, 1899. No. 27763.

Vermont.

Copper Mines in Vermont. Brief account of the mines, ores, etc. 1100 w. *Eng & Min Jour*—May 20, 1899. No. 27-675.

GOLD AND SILVER.

Brazil.

Diamond and Gold Mining in Minas Geraes. Extracts from a report of this region by Mr. Dawson, who has recently visited the country. 8500 w. *U. S. Cons-Repts*. No. 424—May 12, 1899. No. 27-583 D.

British Columbia.

Mining on Vancouver and Texada Islands. W. M. Brewer. A report of these districts, which have been recently visited by the writer. 1700 w. *Eng & Min Jour*—May 6, 1899. No. 27518.

Texada Island. Alfred Raper. A description of the deposits and development of a young and promising British Columbia mining field. 2000 w. *Mines & Min*—May, 1899. No. 27439 C.

California.

California Gold Mines. Arthur Lakes. Illustrates and describes some typical mines situated in Grass Valley, Nevada Co., California, and their high-pressure water-power plants used for the production of compressed air. 3000 w. *Mines Min*—May, 1899. No. 27438 C.

Some Characteristic Mines of the California Gold Belt. W. H. S. Describes some of the characteristics peculiar to each type of vein. 1800 w. *Min & Sci Pr*—May 20, 1899. No. 27777.

Colorado.

The Liberty Bell Gold Mine, Telluride, Colorado. Arthur Winslow. Treats of the location, history, geology, ore composition and values, ore treatment, milling and mining methods. Ill. 4800 w. *Trans Am Inst of Min Engs*—Feb., 1899. No. 27-344 D.

Cyanide.

A Zinc Process for precipitating Gold from Weak Solutions. T. L. Carter. A reply to the discussion of the writer's paper, with a continuation and close of the discussion. 8800 w. *Jour of Chem & Met Soc of S Africa*—March, 1899. No. 27664 E.

Darien, S. A.

Modern Gold Mining in the Darien. Notes on the Re-opening of the Espiritu Santo Mine at Cana. Ernest R. Woakes. An interesting account of the writer's experience at this mine. Ill. 11700 w. *Trans Am Inst of Min Engs*—Feb., 1899. No. 27348 D.

Dredging.

Dredging for Gold. C. C. Longridge. Gives a review of the history of gold dredging, the various dredges used, etc., in part first. 3500 w. *Engng*—April 21, 1899. Serial. 1st part. No. 27431 A.

Gold Veins.

The occurrence of Free Milling Gold

Veins in British Columbia. Wm. Hamilton Merritt. Read before the Canadian Min. Inst. Describes veins of high-grade ore, the granite and schistose quartzite. 1700 w. Can Min Rev—April 29, 1899. No. 27405 B.

Klondike.

Alaska and the Klondike. Angelo Heilprin. Part first describes the writer's journey to this region, in by the White Pass and out by the Chilkoot. Ill. 3800 w. Ap Pop Sci M—May, 1899. Serial. 1st part. No. 27349 D.

Laboratory Tests.

Notes on the Results of Some Laboratory Concentrating Tests of the Ores of Faribault Brook, C. B. F. H. Mason. Read before the Min. Soc. of Nova Scotia. Describes experiments. 1400 w. Can Min Rev—April 29, 1899. No. 27403 B.

Leadville, Col.

Some Notes on the Geology of Leadville, Colorado. Describes the sedimentary deposits in their order, ore deposits, etc. 2300 w. Min & Sci Pr—May 20, 1899. No. 27779.

Mining.

The Minting of Gold and Silver. J. Foster Symes. Brief description of the operations. 2300 w. Yale Sci M—May, 1899. No. 27617 C.

New Zealand.

Great Barrier Island. Albion S. Howe. Describes the locality, the workings and ores. 1500 w. N Z Mines Rec—March 16, 1899. No. 27709 B.

Nova Scotia.

Gold Mining in Nova Scotia from 1860 to 1899. Dr. A. R. C. Selwyn. Showing that mining enterprise has been neglected, and discussing the reasons. 1700 w. Can Min Rev—April 29, 1899. No. 27407 B.

Ontario.

The Gold Bearing Veins of Bag Bay, Near Lake of the Woods. Peter Mackellar. Describes the peculiar features, the smallness of the quartz-fissures as compared with the size of the ore-bearing lodes, and the operations of the Tycoon, Toronto and Western, and Mikado Co.'s. 4000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 27345 D.

Placer Mines.

Forest Hill Placer Mines. Arthur Lakes. How the ancient river beds of Placer County, California, now in the mountain tops, are worked. 1500 w. Mines & Min—May, 1899. No. 27447 C.

Placer Mining and the Future Possibilities of this Branch of the Mining Industry. John W. Gray. A discussion of the outlook in California, especially, for this system of mining. 2000 w. Min & Sci Pr—May 6, 1899. No. 27574.

Prospecting.

An Incident in Systematic Prospecting Connected with the Discovery of the "Rose" Lead, Montague, N. S. George W. Stuart. Read before the Min. Soc. of Nova Scotia. Showing that a knowledge of glacial geology is a great help in prospecting, if not a necessity. 900 w. Can Min Rev—April 29, 1899. No. 27402 B.

La Sal Mountains. Arthur Lakes. A description of the region about La Sal mountains, including Paradox Valley, which has lately been attracting attention, and of which there is little definite information. Ill. 2500 w. Mines & Min—May, 1899. No. 27443 C.

Observations on Some Prospects and Mines Around Breckenridge, South Park, Colorado. Arthur Lakes. Notes taken in a trip made to examine a gold placer property. Ill. 1600 w. Mines & Min—May, 1899. No. 27436 C.

The Diamond Drill in Prospecting. Some points on the manner of using. 1200 w. Min & Sci Pr—May 13, 1899. No. 27666.

Stamp Mills.

The Adjustments and Control of the Stamp Mill. Courtenay De Kalb. Read before the Can. Min. Inst. The importance of determining the design of mill required, of guarding the details of practice, and adapting the treatment to the ore. 4500 w. Can Min Rev—April 29, 1899. No. 27406 B.

Western Australia.

The Kalgoorlie District in Western Australia. Facts concerning the output and treatment of the ores. 900 w. Eng & Min Jour—May 27, 1899. No. 27775.

Yukon.

Preliminary Notes on the Surface Geology of the Yukon Territory. Otto Nordenskjöld. Report of observations made on a journey between the Alaska coast and Dawson City. 3500 w. Am Geol—May, 1899. No. 27549 D.

IRON AND STEEL.

American Conditions.

The American Iron and Steel Industries. A Comparison. Walter Dixon. Read before the West of Scotland Iron & Steel Inst. Impressions of an Englishman on visiting American works. Considers the management, labor, resources, and part played by electricity, with conclusions. 4000 w. Col Guard—April 21, 1899. No. 27430 A.

Analysis.

Pig Iron Analysis. Edmund E. Johnston. A comparative statement of results obtained by different chemists from the same piece of pig iron. 3000 w. Ir Age—May 18, 1899. No. 27653.

Blast-Furnace Gas.

The Use of Blast-Furnace and Coke-Oven Gases. Enrique Disdier. Read before the British Iron and Steel Inst. Considers the disadvantages of these gases as compared with others, and discusses methods of installing coke ovens adjacent to blast-furnaces, and the advantages that accrue. 3500 w. *Ind & Ir*—May 12, 1899. No. 27718 A.

Blast Furnaces.

The Manufacture of Steel Direct from the Ore in the Blast Furnace. Dimitris Tschernoff. Read before the British Iron and Steel Inst. Illustrates and describes a construction of blast-furnace by which this may be attained. 700 w. *Col Guard*—May 12, 1899. No. 27722 A.

Blowing Engines.

See Mechanical Engineering, Steam Engineering.

Cast Iron.

See Mechanical Engineering, Machine Works and Foundries.

Diffusion.

The Diffusion of Elements in Iron. John Oliver Arnold and Andrew M'William. Abstract of a paper read at meeting of the British Ir. and Steel Inst. Illustrates and describes the experimental methods adopted, giving the results of analysis, details of experiments, etc. 3000 w. *Ir & Coal Trd Rev*—May 5, 1899. No. 27606 A.

Gellivare Mines.

The Gellivare Iron Ore Mines. H. Bauerman. Describes the location, deposits, working, shipping, etc. 2700 w. *Col Guard*—May 5, 1899. No. 27611 A.

Hot Blast.

The Use of Hot Blast in the Bessemer Process. J. Wilborgh. Read before the Ir and Steel Inst. On the advantages of the use of the hot blast for the basic Bessemer process and for small converters. 2000 w. *Col Guard*—May 5, 1899. No. 27610 A.

Lorraine.

The Iron Ore Deposits of German Lorraine. (Die Minetteablagerung Deutsch-Lotringens.) W. Albrecht. With geological map and sections of the workings. Two articles, two plates. 7500 w. *Stahl und Eisen*—April 1, 15, 1899. No. 27850, each D.

Open-Hearth.

On Tilting Open-Hearth Furnaces. Archibald P. Head. Illustrated description of the furnace of this type used for the past ten years in the United States, and its advantages. 2700 w. *Ir & Coal Trds Rev*—May 5, 1899. No. 27603 A.

Ore Concentration.

The Groendal-Dellwick Process for the

Concentration of Iron Ore. Dr. Leo, in *Stahl und Eisen*. An account of the vorable results with a large deposit of lean magnetite in Finland, by the use of this process. 1600 w. *Am Mfr & Ir Wld*—April 28, 1899. No. 27385.

Ore Kiln.

Improvement in the Davis-Colby Ore Kiln. Charles J. Christian. Gives the experience of the writer with the kilns as originally constructed and also as modified according to plans shown. 1200 w. *Am Mfr & Ir Wld*—May 5, 1899. No. 27517.

Pig Iron.

See Mechanical Engineering, Machine Works and Foundries.

Production.

Our Iron and Steel Production in 1898. Information from the statistical report of the Am Iron and Steel Assn., compiled by James M. Swanck. 1500 w. *Ir Age*—May 25, 1899. No. 27750.

Progress.

Progress in the Iron and Steel Industries. W. Roberts-Austen. Abstract of a presidential address to the Iron and Steel Inst. A consideration of British efforts in connection with these industries. 7000 w. *Nature*—May 11, 1899. No. 27687 A.

Steel Furnaces.

Mechanical Charging of Steel Furnaces. Henry Tomkins. Abstract of paper and discussion presented at meeting of the Cleveland Inst. of Eng., at Middlesbrough, Eng. Describes a machine invented by the writer, which has given satisfaction during a twelve-month's trial. 3500 w. *Col Guard*—April 28, 1899. No. 27544 A.

Steel Ingots.

A Method of Casting Steel Ingots. Illustrates and describes a method devised by J. K. Griffith, of casting compound ingots, composed of layers of steel of different composition, to overcome the difficulties from segregation and piping, and to insure homogeneous metal. 1200 w. *Ir Trd Rev*—May 4, 1899. No. 27478.

Sweden.

The Iron Industry of Sweden. David A. Louis. A very fully illustrated account of the plant and practice of the Swedish mines and iron and steel industry. 4500 w. *Engineering Magazine*—June, 1899. No. 27895 B.

MINING.**Cave-In.**

Cave-In of the Bon Air Shaft at Leadville, Colorado. An account of how it happened and how the men were rescued after fourteen days imprisonment. 1800

w. Mines & Min—May, 1899. No. 27440 C.

Costs.

A Decade of Progress in Reducing Costs. Charles Kirchhoff. Presidential address at the New York meeting. Presents data indicating to what extent improvements in practice and equipment have affected the cost sheet. 3800 w. Trans Am Inst of Min Engs—Feb., 1899. No. 27347 D.

Electricity.

Electricity in Mining Engineering; Its Uses, Advantages and Defects. Philip Evans. Read before the British Soc. of Min. Students. Considers electricity as applied to lighting, signaling, pumping, haulage, blasting, drilling, coal cutting, and winding. 2000 w. Ir and Coal Trds Rev—May 5, 1899. No. 27604 A.

Explosives.

Experiments Connected With the Detonation of Favier Grisounites. A report of numerous experiments made under various conditions. 2500 w. Col Guard—April 28, 1899. No. 27545 A.

The Use of Blasting Explosives. A. H. Stokes. Considers the principle of the Woolwich test, the application of the explosives in coal mines order, and related matter. 4500 w. Col Guard—May 12, 1899. No. 27721 A.

Gases.

On a Hypothesis to Explain the Partial Non-explosive Combination of Explosive Gases and Gaseous Mixtures. W. G. Mixer. Reviews investigations made, and states the writer's views, based on a study of the phenomena of explosives. 2800 w. Am Jour of Sci—May, 1899. No. 27380 C.

Mexico.

Mexican Methods of Mine Management and Operation. George F. Binckley. Describes the system of working and the business management. 420 w. Min & Sci Pr—April 29, 1899. No. 27457.

Mining in Sinaloa, Mexico. John W. Gray. Some notes on the mines of the state and the extent of their development. 2000 w. Mines & Min—May, 1899. No. 27444 C.

Mine Plant.

See Electrical Engineering, Power Applications.

Mining Law.

Mines Under Rivers, the Foreshore, and Streams and Locks. Essential points and facts of decisions pronounced by the high courts of England on this subject. 2500 w. Col Guard—April 21, 1899. No. 27427 A.

Mining Laws of British Columbia. Copy of a placer mining act passed Jan. 18, 1899. 3600 w. U. S. Cons Repts, No. 413—April 29, 1889. No. 27351 D.

The Colorado Mining Law. A copy of the code of regulations provided for mines in operation, which is a part of a new law which goes into effect July 9. 1800 w. Eng & Min Jour—May 27, 1899. No. 27774.

Panel System.

The Advantages of the Panel System. Gives points in regard to ventilation and states the circumstances under which this system is preferable to others. 1200 w. Mines & Min—May, 1899. No. 27442 C.

Water Hoist.

The Tomson Water Hoist. (Das Tomsonsche Wasserziehverfahren.) A description of the method of removing the water from the shaft of the Minister Achenbach mine during the deepening operation. The water was raised in tanks by the mine hoist. 1000 w. 1 plate. Gluckauf—May 6, 1899. No. 27861 B.

MISCELLANY.

Alloys.

Quick Testing of Lead-Tin and Lead-Antimony Alloys. Joseph Richards. Describes methods of quick determinations sufficiently true for the purpose required. 1200 w. Jour Fr Inst—May, 1899. No. 27502 D.

Aluminum.

The Applications of Aluminum. (Sur les Applications de l'Aluminium.) Henri Moissan. A note to the French Academy, with analyses of commercial samples of aluminum and data as to its endurance under various conditions. 3000 w. Comptes Rendus—April 10, 1899. No. 27838 D.

The Applications of Aluminum. (Sur les Applications de l'Aluminium.) A. Ditte. A reply to the communication of M. Moissan. 1800 w. Comptes Rendus—April 17, 1899. No. 27846 D.

The Impurities in Aluminum. (Sur les Impuretés de l'Aluminium.) A. Minet. An examination of the influence of the method of producing aluminum upon the impurities contained in the resulting metal. 1800 w. Comptes Rendus—May 8, 1899. No. 27846 D.

Bronze.

See Mechanical Engineering, Machine Works and Foundries.

Corundum.

The Corundum Deposits of Ontario. T. W. Gibson. An account of the discovery of the mineral in the eastern part of the province of Ontario, describing the deposits, and giving their value. 1700 w. Eng and Min Jour—April 29, 1899. No. 27368.

Fluor Spar.

Fluor Spar Deposits in Kentucky. Richard Moldenke. Describes this spar and states the localities where it is found,

and peculiarities of the deposits, the purposes for which it is used, etc. 2000 w. Ir Trd Rev—May 11, 1899. No. 27592.

Manganese.

The Manganese Mines of Brazil. (Les Mines de Manganese au Bresil.) Daniel Bellet. A general review of the deposits in Brazil, with data of costs of mining and transport. 2000 w. Revue Technique—April 25, 1899. No. 27807 D.

Petroleum.

Prospecting for Oil in an Untried Region. Arthur Lakes. How oil was found in Colorado, where there were no direct indications on the surface. 1700 w. Mines & Min—May, 1899. No. 27448 C.

Some Notes on the Petroleum Deposits of California. Harold W. Fairbanks. States the conditions under which petroleum occurs in California and which seem

to differ from Prof. Orton's statements concerning eastern fields in respect to migration. 1200 w. Min & Sci Pr—May 20, 1899. No. 27776.

Quicksilver.

The Ohacawai Quicksilver Deposits. André P. Griffiths. Read before the N. Z. Inst. of Min. Engs. Results of prospecting and mining operations, giving locality, geological features, deposits, their origin and formation and describing the furnaces. 4400 w. N. Z. Mines Rec—March 16, 1899. No. 27710 B.

Slate.

The New York Slate Industry. J. Nelson Nevius. Part first gives the location of the slate belt and illustrated description of some of the quarries. 2200 w. Eng & Min Jour—May 20, 1899. Serial. 1st part. No. 27674.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Train Accidents in the United States in March. Detailed list and classified summary. 3500 w. R R Gaz—May 12, 1899. No. 27585.

Claim Agents.

The Claim Agent and His Relation to the Safety of Employees. L. L. Gilbert. Abstract of a paper read before the St. Louis Ry. Club. On the attitude of their agents, the best way to settle claims, safety devices, inspection, etc. 1300 w. R R Gaz—May 19, 1899. No. 27671.

Loading.

The Loading of Long Structural Material. The latest revised form of the rules and regulations of the Master Car Builders' Assn. for the loading and carrying of structural material. Ill. 4000 w. Bridges—May, 1899. No. 27685 C.

Mileage.

The Michigan Mileage Case. Extracts from the opinion of the United States supreme court, with editorial comment. 4700 w. Ry Age—April 28, 1899. No. 27389.

FINANCIAL.

Russia.

Railroad Business in Russia in 1893. Reports the increase in mileage, total length of lines, projected lines, and other matters relating to the railroad interests. 1100 w. U. S. Cons Repts. No. 434—May 24, 1899. No. 27741 D.

MOTIVE POWER AND EQUIPMENT.

Austria.

The Development of Locomotives and Cars in Austria. From the *Zeitung des Vereins*. Descriptive. 1400 w. R R Gaz—May 12, 1899. No. 27587.

Brasses.

See Mechanical Engineering, Machine Works and Foundries.

Coal Cars.

80,000-Pound, 35-Foot, Coal Cars. Drawings and description of a new design for drop-bottom coal cars of the gondola type. 1100 w. Am Eng & R R Jour—May, 1899. No. 25393 C.

Fast Runs.

Fast Runs on the Burlington. Summaries of two very fast runs made on this road on April 14 and 22, 1899. 400 w. Ry Age—April 28, 1899. No. 27390.

Foreign Practice.

The Impression of a Motive Power Man in a Trip Abroad. R. H. Soule. Prepared for the Texas Ry. Club. A record of observations that interested a motive power man during a trip to Russia and South Africa. Ill. 1800 w. R R Gaz—May 12, 1899. No. 27586.

Locomotive.

See Mechanical Engineering, Power Applications.

Locomotive Boiler.

The Wootten Boiler. S. M. Vauclain. Considers the origin, evolution, and advantages for high speed, for greater horse-

power, for inferior fuel. General discussion and illustrations. 920 w. N. Y. R R Club—April 20, 1899. No. 27663.

Locomotive Performance.

The Ton-Miles Per Hour. George S. Hodgins. Discusses the unsatisfactory method of appraising the performance of a locomotive by giving its number of car miles, and the more accurate method of using the ton-mile. 1600 w. Loc Engng—May, 1899. No. 27357 C.

Locomotives.

A Heavy Express Locomotive for the Lancashire & Yorkshire. J. Pearson Pattinson. Illustrations and dimensions of a powerful engine, with facts concerning it. 900 w. R R Gaz—May 19, 1899. No. 27672.

Amount and Distribution of Work in Building a Locomotive. Editorial discussion of an article by T. R. Browne, which is considered to contain much valuable information. 1700 w. Am Eng & R R Jour—May, 1899. No. 27398 C.

Compound Consolidation Locomotives for the Southern Pacific. Descriptive specification with engraving. 500 w. R R Gaz—May 5, 1899. No. 27497.

Consolidation and Mogul Locomotives. General dimensions and illustrated descriptions of compound consolidation, and simple mogul locomotives. 1000 w. Am Eng & R R Jour—May, 1899. No. 27395 C.

Express Passenger Locomotive for the French State Railways. General and detailed views, short description and leading particulars. 500 w. Engng—April 21, 1899. No. 27432 A.

Fast Passenger Locomotives of the Chicago and Northwestern Railway. Illustration and principal dimensions of new eight-wheel locomotives to be used in fast service between Chicago and Omaha. 900 w. R R Gaz—May 26, 1899. No. 27769.

Heavy Locomotives for the Lake Shore. Illustrated description of these new engines which are the heaviest yet put in service on this road. 900 w. Ry Age—April 28, 1899. No. 27391.

Heavy Passenger Locomotive for the Vandalia Line. Illustration general dimensions and description, with account of a run made April 21, with a train of five cars. 1000 w. Ry. & Engng Rey—May 20, 1899. No. 27727.

High-Speed Simple Passenger Locomotives. Clement F. Street. Abstract of a paper presented at the March meeting of Western Ry Club. Details regarding the locomotives used in the United States in high-speed passenger service. 2200 w. Eng News—May 4, 1899. No. 27464.

Locomotive Repairs and Renewals. R. Price-Williams. Calculations on the average life of a locomotive and the amounts

necessary to maintain it in an efficient condition during that period. 1000 w. Engng—May 5, 1899. No. 27616 A.

New Coupled Express Engines on Great Western Railway. Charles Rous-Marten. Briefly reviews the types used for express running by this road, and describes the new engines known as the Badminton class, of which twenty have been built, giving report of runs. 1800 w. Engr, Lond—April 28, 1899. No. 27-536 A.

Tank Engine for South Africa. Dimensions and illustrated description of one of six engines recently constructed for the Pretoria and Pietersburg Railway. 800 w. Engr, Lond—May 5, 1899. No. 27613 A.

The Midland's American Engines. Photograph and brief description of these engines, with extracts from a letter by Clement E. Stretton, in the *Leicester (Eng.) Daily Post* concerning the points wherein they differ from English locomotives. 800 w. Transport—May 5, 1899. No. 27632 A.

Vauclain Fast Passenger Compound Locomotives. Engraving, with the chief characteristics of the design. 700 w. Am Eng & R R Jour—May, 1899. No. 27-392 C.

Speed.

The Atlantic City Flyer—Philadelphia & Reading Railway. H. H. Vaughan. An analysis of the performance of one of the engines of the Atlantic type on the fifty-minute run from Camden to Atlantic City. 1000 w. Am Eng & R R Jour—May, 1899. No. 27399 C.

Stacks.

A Chapter on Locomotive Stacks. A series of drawings showing the variety of designs of stacks covering the experience of the Union Pacific Ry. from 1864 to the present time. 600 w. Am Eng & R R Jour—May, 1899. No. 27399 C.

Trucks.

The Bogie Truck. Maurice Demoulin. An illustrated review of the different types of bogie trucks in use in the United States. The present number deals with freight car trucks. 2400 w. R R Car Jour—May, 1899. Serial. 1st part. No. 27558.

Train Resistance.

A Formula for Train Resistance. Henry Graftio. Gives some of the results secured abroad. 3900 w. St Ry Jour—May, 1899. No. 27452 D.

NEW PROJECTS.

Improvements.

Long Island Railroad Improvements. An illustrated account of improvements made and proposed, which will cost about

a million dollars. Includes a tunnel under the East River. 1000 w. R R Gaz—May 5, 1899. No. 27494.

Railroad Building.

New Railroad Building in 1898. Revised figures of the total mileage of new roads built in United States, Canada and Mexico. 3500 w. R R Gaz—May 26, 1899. No. 27771.

Railroad Improvements.

The Brooklyn Terminal Improvements and East River Tunnel of the Long Island R. R. Considers the plan of this road to furnish an all-rail route from the suburban towns on Long Island to the business centers of Brooklyn and Manhattan. Also editorial. Ill. 3800 w. Eng News—May 18, 1899. No. 27669.

Railway Location.

An Interesting Piece of Railway Location. Gives a contour map showing interesting work in the Gokteik gorge, on an extension of the Burma Ry. 900 w. Ry & Engng Rev—May 20, 1899. No. 27728.

Switzerland.

New Railway Projects in Switzerland. (Neue Schweizerische Eisenbahn Projekte.) R. Moser. A discussion of the plans for the extension of the Swiss Railways consequent upon the acquisition of the entire system by the government; with especial reference to the Weissenstein railway. 3000 w. Schweizerische Banzeitung—April 8, 1899. No. 27832 B.

Upper Burma.

The Mandalay-Kunlon Railway. E. Wynan Wagstaff. Deals with a portion of the line from the valley of the Irrawaddy to that of the Salween, now in process of construction. Map. 1400 w. Ind Engng—April 8, 1899. No. 27575 D.

PERMANENT WAY AND FIXTURES.

Albany Station.

New Union Passenger Station at Albany, N. Y. An illustrated general description of the new union passenger station now being built. 9000 w. Ry & Engng Rev—May 6, 1899. No. 27554.

Boston Station.

The Boston Southern Station. J. P. Coleman. Illustrates and describes the track facilities and interlocking which give this station the greatest traffic possibilities in the world. 3000 w. R R Gaz—May 12, 1899. No. 27584.

Concrete Masonry.

Concrete as a Railway Masonry. W. A. Rogers. A brief outline of railway concrete masonry, describing the main features in its construction. 2500 w. Wis Engr—May, 1899. No. 27660 D.

Construction.

Permanent-Way Construction. (Vom Eisenbahn-Oberbau.) H. Claus. With especial reference to the use of steel sleepers, and heavier rails, with data from the St. Gothard and the Liège-Limburg railways. 3000 w. Glaser's Annalen—April 15, 1899. No. 27847 D.

Omaha Stations.

The New Railway Stations at Omaha, Neb. Introductory account of the various projects for station improvement in this city, and illustrated description of the Burlington station. 2800 w. Eng News—May 4, 1899. No. 27462.

Road Bed.

The Conditions Existing Under Railway Sleepers. (Ueber die Vorgänge unter der Schwelle eines Eisenbahngleises.) A study of the action of the pressure on the sleepers upon the ballast beneath; with many illustrations. 4500 w. Glaser's Annalen—May 1, 1899. No. 27849 D.

St. Gothard.

The St. Gothard Railway. (Le Chemin de Fer du St. Gothard.) Jules Michel. Describing especially the permanent way, and the results of the reconstruction of portions with steel sleepers. 4000 w. Rev Gen de Chemins de Fer—May, 1899. No. 27811 F.

Signaling.

Block Signaling and Interlocking on the Chicago, St. Paul, Minneapolis & Omaha Ry. Describes the operation of the telegraph block system, the automatic signals and the interlocking plants. Ill. 2500 w. Eng News—May 25, 1899. No. 27754.

Block Signaling. J. P. Coleman. Illustrates and describes some modern methods used extensively in America, showing the advancement made on early practice. 7000 w. Wis Engr—May, 1899. No. 27656 D.

Electric Interlocking Apparatus. (Les Appareils de Vérouillage Electrique.) M. Bouvier. An illustrated description of the electrical signal apparatus used on the Paris-Lyons-Mediterranean Railway. 7500 w. 2 plates. Rev Gen des Chemins de Fer—May, 1899. No. 27810 F.

Interlocking Plant at Pacific Junction; Chicago, Milwaukee & St. Paul Ry. Illustrated description of a plant at a complicated junction. 900 w. Eng News—May 11, 1899. No. 27593.

Revolving Signal for Cabooses. Illustrates and describes an apparatus which has been in experimental use on the Chicago, Rock Island & Pacific, and on other roads. 600 w. Ry & Engng Rev—May 13, 1899. No. 27623.

The Relative Importance of Train Signalling Indications. J. Pigg. An explanation of the meanings of different indications, and their relative importance.

1400 w. Elec Eng, Lond—May 5, 1899. No. 27639 A.

The Track Circuit. C. C. Anthony. An explanation of the requirements and advantages of this system. 1800. Elec Wld & Elec Engr—April 29, 1899. No. 27363.

Switch Stand.

The Flickinger Switch Stand, L. S. & M. S. Ry. Illustrates and describes a switch stand in which the safety device is operated by the action of the switch stand itself. 900 w. Ry & Engng Rev—May 6, 1899. No. 27555.

Tunis.

The Railway from Sfax to Gafsa, Tunis. (Le Chemin de Fer de Sfax à Gafsa.) With map of the route, elevation of the track-laying machinery, and views of the

terminals. 1500 w. Genie Civil—April 22, 1899. No. 27803 D.

TRAFFIC.

Coal Traffic.

The Great Central New Coal Traffic Arrangements. An account of the special arrangements for dealing with the universal traffic from the Midlands and North of England since the opening of this line to London. Ill. 1100 w. Ir & Coal Trds Rev—May 5, 1899. No. 27605 A.

Rates.

Home and Foreign Railway Rates for Goods Traffic. B. H. Thwaite. Summary of an address delivered before the London Chamber of Commerce. Advocating the low freight policy. 1500 w. Prac Engr—April 28, 1899. No. 27533. A.

STREET AND ELECTRIC TRAMWAYS

Accounting.

Accounting System of the Omaha & Council Bluffs Railway & Bridge Co. Describes the monthly report and comparative statement blanks designed by W. S. Dimmock. 3000 w. St Ry Rev—May 15, 1899. No. 27730 C.

Boston Elevated.

The Boston Elevated Railway. Illustrated description and general information. 3800 w. Eng News—May 11, 1899. No. 27597.

Brake.

Electric Brake for Trailers. (Elektrische Betriebs-und Nothbremse für Anhängewagen Elektrischer Bahnen.) Describing a form of brake for trailing cars on electric tramways; a magnet holds the brake out of contact unless the coupling breaks. 1000 w. Elektrotech Zeitschr—May 4, 1899. No. 27876 B.

Construction.

Overhead Line Construction. Albert B. Herrick. Relates to the selection and erection of apparatus and methods of construction. Ill. 4000 w. St Ry Jour—May, 1899. Serial 1st part. No. 27450 D.

Contact System.

The Electric Tramways of Tours. (Tramways Electriques de Tours.) E. Dieudonne. An illustrated description of the Diatto system, as installed at Tours, France. The current is conveyed to the cars by a pin-contact system, from an underground conductor, there being no slot in the street. 2000 w. Revue Technique—April 25, 1899. No. 27806 D.

The Surface Contact System of the Union-Elektricitätsgesellschaft. (Das Oberflächenkontaktsystem der Union-Elektricitätsgesellschaft.) M. Kubierschky. A

general description of the General Electric Company's system as applied in Germany. 4500 w. Elektrotech Zeitschr—April 27, 1899. No. 27873 B.

Electrical Machinery.

The Electrical Inspection of Street Car Equipments. Albert B. Herrick. Describes means by which troubles are detected and located. Ill. 4000 w. Jour Fr Inst—May, 1899. No. 27501 D.

Electric Railways.

Right of Way, Grades and Grade Crossings of Electric Railways. Editorial discussion of the litigation over the proposed purchase of a right of way for a portion of the new Aurora & Geneva Electric Ry. in Illinois, giving particulars of the case. 5000 w. Eng News—May 18, 1899. No. 27670.

The Omaha & Council Bluffs Railway & Bridge Co. Illustrates and describes a railway equipped in 1888. 3500 w. St Ry Rev—May 15, 1899. No. 27729 C.

Electric Traction.

The Influence of Electricity Upon Railway Locomotion. B. H. Thwaite. With especial reference to the practicability of applying electric traction to underground and main line railway service where steam locomotives are now in use. 4000 w. Engineering Magazine—June, 1899. No. 27894 B.

Indispensable Accessories of Electric Traction. Henry E. P. Cottrell. Part first illustrates and discusses the various types of modern electric car trucks, and the requirements they must fulfill. 3400 w. Elec Rev, Lond—April 28, 1899. Serial. 1st part. No. 27528 A.

Electrolysis.

Electrolysis as an Unsolved Municipal

Problem. H. S. Wynkoop. Extract from a paper read before the Eng's. Club of Brooklyn, N. Y., giving a report of an investigation made of the Brooklyn water mains. 1800 w. Elec Wld & Elec Engr—April 29, 1899. No. 27365.

Gas Engine Plant.

Test of an Electric Railway Power Plant Driven by Gas Engines. E. Hill, Jr., and J. C. Brocksmith. Test made for a graduating thesis of a novel plant at Huntington, Long Island. 1600 w. Sib Jour of Engng—May, 1899. No. 27762 C.

Indianapolis.

The Indianapolis Street Railway Franchise. A review of a 34-year franchise for which the company pays \$1,160,000 cash and promises to spend over \$1,000,000 in improvements of track and equipment under the direction of the local board of public improvements. 1500 w. Eng Rec—May 13, 1899. No. 27576.

Interurban.

Analysis of the Operation of an Interurban Railway. A study of the Lorain & Cleveland Railway Company's line, which has a length of 18.5 miles. Ill. 6500 w. St Ry Jour May, 1899. No. 27449 D.

Large Interurban Electric Railway in Southwestern Missouri. An illustrated account of the road connecting Carthage, Carterville, Webb City and Joplin. 2800 w. St Ry Jour—May, 1899. No. 27451 D.

Jungfrau.

The Jungfrau Railway. (Le Chemin de Fer de la Jungfrau.) H. Martin. A very complete account of this important Swiss mountain road, with details of the hydraulic and electric plant and of the three-phase system adopted; also of the road structure, tunneling, etc., and photographs of the present condition of the work. Two articles, two plates. 7500 w. Génie Civil—April 22, 29, 1899. No. 27802 each D.

Locomotive.

See Electrical Engineering, Power Applications.

Motormen.

School for Motormen. Describes the training methods in use by the Metropolitan Street Railway Co., of New York. Ill. 1200 w. St Ry Rev—May 15, 1899. No. 27732 C.

Mountain Road.

The Electric Railway between Stansstadt and Engelberg.) Die Elektrische Bahn Stansstadt-Engelberg.) A very full

account of this important Swiss mountain road. The three-phase system is used and a ladder-rack between the rails. 3000 w. Zeitschr d Ver Deutscher Ing—April 15-1899. No. 27815 D.

The Stansstadt-Engelberg Electric Railway. (Die Elektrische Bahn Stansstadt-Engelberg. A description, with map and many illustrations, of the new electric rack-railway from Stansstadt, on the Lake of Lucerne to Engelberg, nearly 2000 feet above, at a distance of about 14 miles. Two articles. 3500 w. Schweizerische Bauzeitung—April 15, 22, 1899. No. 27833 each B.

Power Calculation.

An Analytical and Graphical Method of Computing the Resistance to Starting and Stopping on Electric Tramways. (Eine Analytische und Graphische Methode zur Berechnung von Anfahr- und Bremswiderständen für Elektrische Eisenbahnen.) F. Erens. An elaborate mathematical analysis, showing that rational methods can be used in practice instead of the empirical ones formerly in vogue. 6000 w. Elektrotech Zeitschr—April 20, 1899. No. 27872 B.

Rolling Stock.

Maintenance and Repair of Rolling Stock. J. W. Greer. On the management of the mechanical department and the wisdom of letting employees understand that there is considerable on the expense side of the ledger. 1800 w. St Ry Rev—May 15, 1899. No. 27731 C.

Signaling.

An Automatic Block System for Single-Track Electric Railways. Illustrates, and describes a system which has been in successful operation on a branch of the Lowell & Suburban Ry. in Massachusetts, and has just been installed on the main road. 1600 w. Eng News—May 25, 1899. No. 27756.

Tramways.

The Potteries Electric Tramway. Illustrated description of an extensive system of tramways in England, which will now have electric service. 2500. Elec Eng. Lond—May 19, 1899. No. 27795 A.

Tramway Conversion.

The Conversion of the Zurich Tramway for Electric Driving. (Der Umbau der Zürcher Pferdebahn für Elektrischen Betrieb.) P. Schenker. With details of methods of drainage, track-laying, bonding, etc. Serial. Part I. 2500 w. Schweizerische Bauzeitung—May 6, 1899. No. 27835 B.

THE ENGINEERING MAGAZINE

VOL. XVII.

AUGUST, 1899.

No. 5.

THE DEVELOPMENT OF GERMAN SHIP-BUILDING.

By Rudolph Haack.

I.—HISTORICAL REVIEW.

IN these closing years of the century a backward glance at the events which characterized it may not be without interest. In the very foreground stands the immense advance in manufacturing of every kind and description in every civilized country, both of the Old and the New World. Almost to the very middle of this artificial division of time, manufacturing occupied a very modest rank as a profitable occupation either for individual or nation, but to-day it has passed all others. Many of its subdivisions were then unknown, such for example as the whole division of electric technology; others, several thousand years old, like ship-building, have, during the century now almost gone, become wholly changed, the only thing in common between the past and the present being the production of something which floats, and which by the conservatism of language, is still called a ship. This transformation will at once be recognized when comparison is made between the largest wooden ship of the first decade of the century, and such a ship was the largest thing then made of its kind, with the largest and fastest passenger steamer of the present.

* The series of papers by Herr Rudolph Haack, the former director of the great Vulcan Works at Stettin, of which this is the first installment, form a record of one of the most marvellous engineering developments of the century. The story of the growth of ship-building in Germany will bear studying by both English and American ship-builders, and not by ship-builders only, but by all branches of the engineering profession. The introductory paper which is here given will be followed by three others, copiously illustrated, and telling most fully how Germany has not only shaken off her dependence upon other countries for her own ships, but has also invaded the markets as an industrial competitor who must be sternly reckoned with hereafter.—THE EDITORS.

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Attempts to supplant wind by steam had already been made early in the eighteenth century, but up to the beginning of the nineteenth no practical success had been attained, this coming only later. The sailing ship was still the only link between countries or lands divided by seas or lakes, and its perfection was the chief aim of ship-builders even into the fourth decade. Wood was the chief material and the only metal fastenings were the nails and bolts.

The equipment of a ship was also composed much more of wood than of iron, examples being the capstans for anchors and cargo, and the wheel for steering gear. Next to the body of the ship came the masts, also of wood, the rigging and sails, whose excellence and adaptation were problems to be solved by the sole director of all, the ship-builder. He alone directed the whole construction, and in well equipped ship-yards there were the shops of the smiths, carpenters and sail-makers, etc., so that outside craftsmen were scarcely employed at all.

How different to-day! The naval constructor is charged with the important duties of designing the lines, of calculating the strength of all materials and trusses, as well as the assembling of the hull of the ship and its compartments; but the construction of the engines with all their details, their installation, trial and operation, these belong wholly to the mechanical engineer. The mental equipment required for each of these departments must be so exhaustive and varied that they are very rarely combined in one man, the duties of each in a great yard being so important and numerous, that it is essential to keep the two divisions distinct, and therefore each is usually under its own head.

Under these heads or masters a whole staff of engineers, specialists, foremen and workmen is employed, to build only the two main parts of the ship, *i. e.*, the hull and the machinery. When this work is done, the design and installation of the many appurtenances and furnishings of the fast steamer of recent years is taken in charge by an army of specialists, machinists, electricians, plumbers, lighters, and many other engineers. Architects, sculptors and painters of renown are charged with the interior and exterior decoration worthy of so great a work, and other masters and workmen of all kinds, such as carpenters, painters, gilders, metal workers, sail makers, rope makers, riggers, etc., must contribute with their skill what appertains to their trades. If we follow construction a further step backwards to the production of all raw materials used in a great ship, there is scarcely a trade or specialty in all the whole sweep of manufacturing industries



BUOY-SETTING STEAMSHIP FOR THE IMPERIAL YARD AT WILHELMSHAVEN.

(Built by Jos. L. Meyer at Papenburg.)

which does not contribute a part either to the ship itself or to its details.

Yet more plainly marked in the difference in cost is the difference in importance to the manufacturing industries between a ship of the first years of the century and of its last years. In former days, both in Germany, and with few exceptions also abroad, among seafaring nations, a bark of five hundred net tons register was a ship of the largest size; the cost in wood, finished, equipped and ready to sail being from \$12,000 to \$12,500, of which about 60 per cent. went to the hull of the ship and about 40 per cent. for equipment, such as anchors, sails, rigging and all the other movable inventory. The recent fast passenger steamer of the largest size costs about \$3,250,000, or 260 times as much as the above specified sailing ship.

Of this large sum the machinery calls for \$1,625,000, the body of the ship for \$1,250,000 and the general furnishing and appurtenances about \$375,000.

While therefore, a hundred years ago the ship builder directed and completed the building of a ship from beginning to end, to-day, in the great and fast passenger steamer, he has charge of only 50 per cent. of the total work, and even then, 11.5 per cent. of the total, or 23 per cent. of his share goes to appurtenances and furnishings. The

half of the whole cost the mechanical engineer expends for the powerful machinery to force the colossus along at the tremendous speed demanded to-day.

Naturally in this radical evolution of ship-building, the first of all naval nations led the way. England first built ocean-going steamers, and again it was England who first used iron to drive wood from its vested rights in ship-building, rights which had existed for thousands of years. Soon all nations ordered all their iron merchant steamers from England and many of the naval powers ordered their battle ships from English yards, only a few, like the United States, France and Sweden, building these latter in their own government navy yards. Naturally, therefore, shipbuilding developed to great perfection in Great Britain, and this makes it difficult even to-day for other nations to retain even a part of the enormous sums poured constantly into England for new steamers or for repairs on old ones.

For a long time these conditions prevented German ship-builders from making any progress in their products, and in addition there were other discouragements. Glancing back to the early years of the century we find very disheartening political conditions, checking any development either of commerce or industry on the continent of

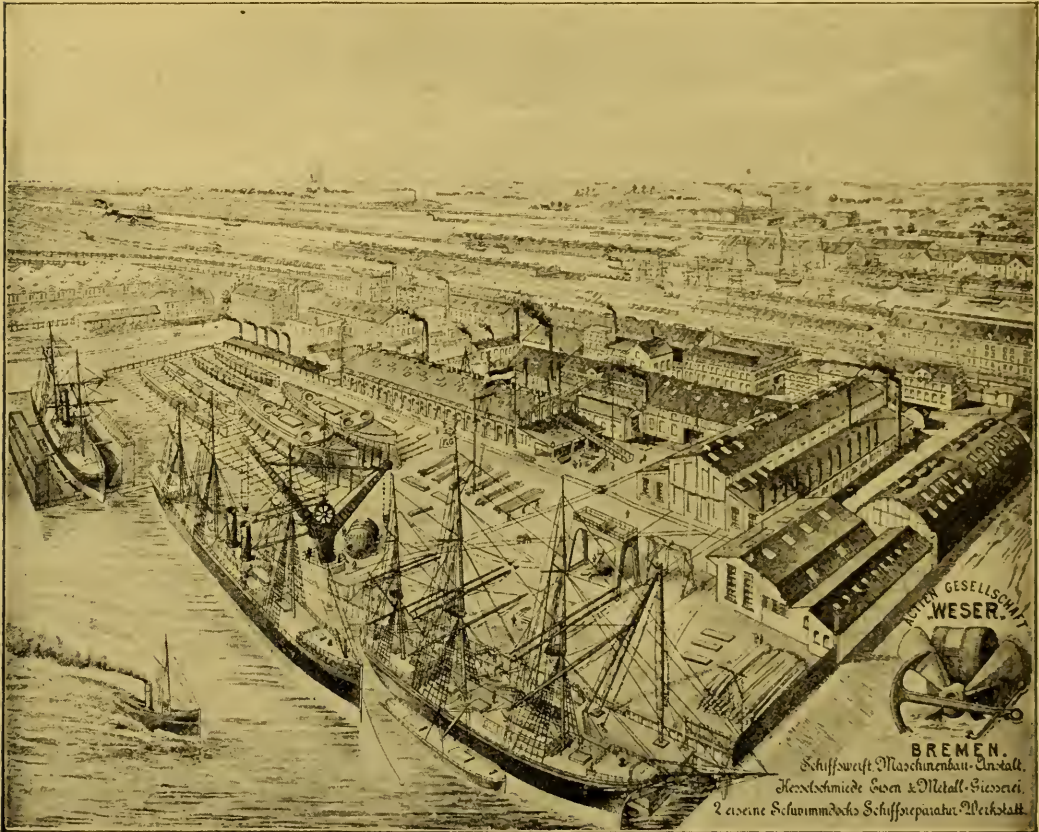


RIVER STEAMBOAT FOR SERVICE IN AFRICA.

(Built by Jos. L. Meyer at Papenburg.)

Europe. The all-powerful emperor Napoleon choked all commerce by his continental blockade, and only on American smugglers were the very necessities of life, both in food and manufactured articles, brought to continental ports from England.

When this obstacle was removed by the triumph of the war of liberation, 1813 to 1815, the internal weakness of Germany and the jealousies between the governments of the many independent states



VIEW OF THE "WESER," SHIPBUILDING COMPANY AT BREMEN.

prevented any rapid growth of commerce and industry. Everywhere means and conditions were lacking for a stronger development, and the absence of any demand for ships left the few ship yards of the North Sea and the Baltic deserted. Not only were there no orders, but the masters and journeymen had gone to the war and many never came back, others were impoverished, and so the whole ship-building industry of Germany lay crippled.

The recovery was very gradual, activity slowly beginning again in the yards and the business being taken up where it had been left before the war, the first ships being in design and tonnage like the older ones. Gradually change was brought about in the North Sea

ports by the great increase of emigration of Germans to the United States, which stimulated especially the passenger business. The new sailing ships were built for greater speed, and the holds, hitherto mere dark boxes for freight, were remodeled for the accommodation of passengers. The merchants of Hamburg and Bremen also began to send out their merchant ships to Central and South America, to West Africa, to Mediterranean shores. These vessels carried German manufactured articles to those countries and brought back tobacco, cotton, etc., and for these purposes larger and larger ships were used. This stimulated the ship builders of the North Sea coast, their profits increased and the yards on the Elbe and Weser became more and more active, so that they were in a most flourishing condition between 1830 and 1850.

The Baltic trade was chiefly confined to that with English ports. Ships exported such German products as wheat and lumber, and returned laden with coal and iron. There were very few houses in the harbors on the Baltic who attempted transatlantic voyages with their ships. Accordingly, on the Baltic, with few exceptions, the ships built were no greater in tonnage than those of the previous period of activity, but the number of yards grew amazingly. Small harbors would have two or three, and even in the villages everybody was ship-building. The yards were overrun with orders, and very soon the sailing fleets of the North Sea and Baltic were imposing in importance and number of ships.

At first abundant supplies of ship timbers were drawn from the North German forests, near the coast, this timber also being exported to France and England. As these sources of supply were exhausted, draughts were made on the forests further inland, and later on splendid oak and fir timbers were brought from Poland and distant Galicia. There was but little use for iron. The few nails, bolts, or bands for masts and spars, came from Sweden or England, and especially copper and its alloys for similar use or for external sheathing below the water line came almost exclusively from England. Hemp for ropes was drawn from Russia, but sails again from England, etc., so that the industry was very dependent on imports of material from abroad. Little by little this dependence decreased and in the fifties, the last decade in which wooden ship building flourished, German industry had made so much progress and freights had been so reduced that nearly all essential supplies were drawn from German sources.

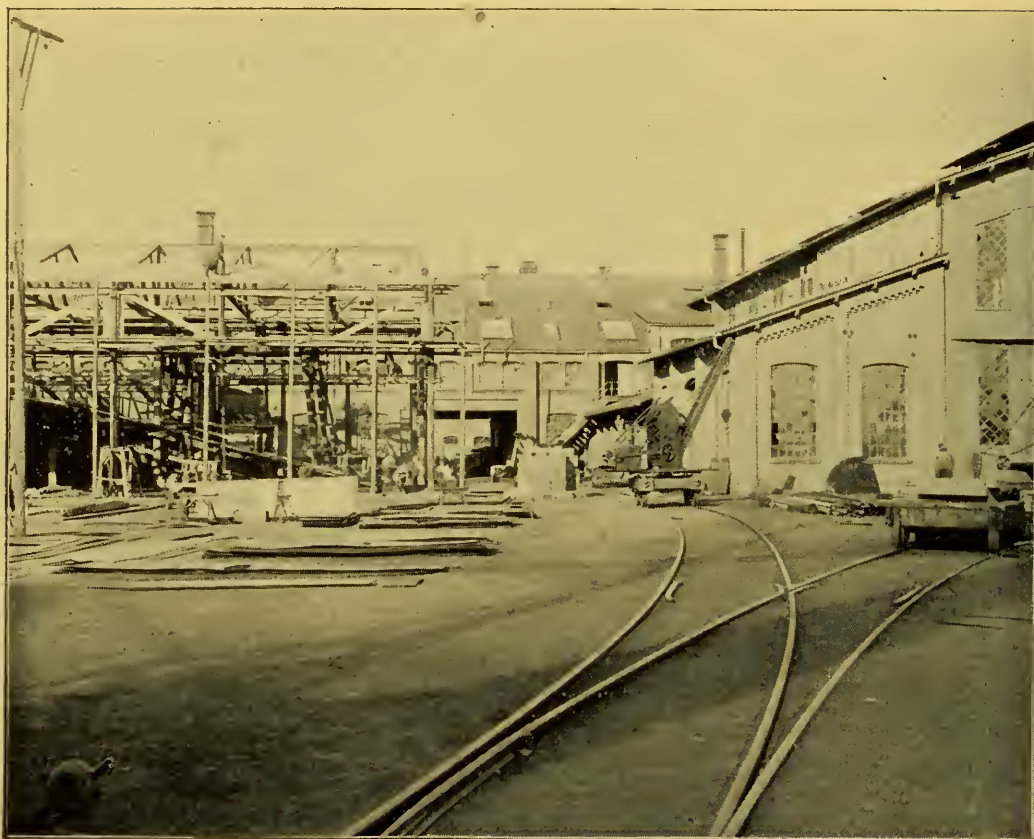
The mastery and direction of a ship yard in those days was generally in the hands of its owner, a master ship-builder, who, according

to the customs of the time, had been obliged to prove his knowledge and skill. He had to serve as apprentice and journeyman for a legally determined number of years, and only became a master ship builder after passing the required examination. This was a very mild strain. The tests proposed were the building of a sailing ship and an estimate of cost for a special design. There was in addition a verbal examination in which a few questions had to be answered as to the method of work, rigging, etc. Any experienced ship builder could teach the trade to any competent, steady, and reasonably intelligent apprentice or journeyman. The desire for greater experience and higher theoretical skill led many who hoped to become masters to go abroad to acquire there this greater knowledge. The ship building school in Copenhagen under the direction of the engineers of the Danish War Marine, gave advantageous opportunities, and also in Sweden there were teachers who were specialists in theoretical ship building. To these countries many young German masters journeyed to perfect their knowledge. Later on, in the Hansa cities, Hamburg, Bremen, etc., private schools were started for eager young ship builders, and



STEAMSHIP "CERES."

(Built by the "Weser" Shipbuilding Company for the Neptune Steamship Company.)



YARDS OF THE "WESER" SHIPBUILDING COMPANY, BREMEN.

near Stettin, in the thirties, the Prussian government founded a school in which there was a preparatory course in higher mathematics and a full course in construction and theory of ships.

This scientific training acquired by the managers of the larger yards, united with the practical experience gained in years of work by the masters and journeymen, led to very great perfection in the building of wooden ships in Germany, and when in the United States the splendid clippers were built, many prospective master ship builders seized the chance to perfect their skill in American yards, and the effect was soon seen in the large sailing ships of clipper build launched between 1850 and 1860 in Bremen and Hamburg.

Shortly before this period on some of the German rivers a few steamboats were carrying passengers, or were acting as tug boats. At first they were built wholly abroad, later the machinery alone was imported and fitted in wooden hulls of German production. But in England and America energetic attempts were making to substitute steam driven paddles or screws for sails, on sea-going vessels, and these efforts had met with such practical success that steamers were substituted for sailing vessels, both for passenger and express freight busi-

ness. Built of wood, after almost identical models, and on almost identical lines, equipped with masts, rigging and sails, these steamers closely resembled their wind-driven prototypes. The chief difference in appearance was caused by the paddle wheels and paddle wheel boxes.

Between 1840 and 1850 England had already begun to build iron ships, and this industry grew very rapidly and as a consequence laid waste the German yards. A very few managed to exist on repair work, and fewer yet with large capital and favorable situations were transformed into yards for the construction of iron ships. Together with a few new yards on the North Sea and Baltic coasts, started solely for building iron ships, or developed by additions to already existing machine shops, they all suffered from paresis and England captured all the orders for new steamers of large size. Small steamers of small profit to builders were ordered in Germany, and this forced the existing machine yards either to turn their establishments into other lines of manufacture, or in the case of new plants to neglect ship building for other branches of iron work. Even when Prussia began to develop her war fleet, after 1848, very little benefit accrued to private yards. The wooden hulls, excepting those of steam gun-boats and for the corvette *Danzig*, were built at the Government navy yard in Danzig, and the steam engines were ordered from famous British



LAUNCH AT THE "WESER" SHIPBUILDING COMPANY'S YARD, BREMEN.

yards, whose experience in such matters was so far ahead of that of Germany. To give this necessary practical experience to German engine builders, they were given the orders for the little gun-boats and later on they were intrusted with the building of the engines for corvettes, etc.

Shortly before 1870 the government naval authorities established at Kiel and Wilhelmshaven yards for the repair and also for the building of large battle-ships, especially for the ultimate purpose of building all the new navy either in these new yards or at Danzig. When



ARMoured GUNBOATS.

(Built by the "Weser" Shipbuilding Company.)

however, after the war with France a German fleet of home manufacture had to be created rapidly, the capacity of the government navy yards was overtaxed, and the private yard "Vulcan" at Stettin received the order for the building of the armoured frigate *Preussen*, the armour, however, not being included in the order, as this was reserved for the government yard at Kiel. This order marks the date of the revival, one might almost say the beginning, of modern German ship-building, for this private yard "Vulcan" succeeded in executing this large order so quickly and satisfactorily, as well as that for the armour plating of the iron clad *Preussen* and the building of the armoured corvette *Hansa* that it won the entire confidence of the Imperial Ad-

mirality and gave proof that the plans and designs of German naval engineers even for the largest battle-ships of that day could be executed in Germany, thus removing the hitherto almost ineradicable mistrust of home yards.

This much coveted success did not however have the wished-for influence on the great steamship companies of Germany. From 1855 on, the steam fleet of the Hamburg Packetfahrt Company, and of the North German Lloyd grew rapidly to positions of the first rank, but only a few of their smallest vessels came into existence in German yards. Still in 1880, when the latter company prepared to order the first of the fast steamers, the directors requested tenders from German yards as well as from British firms. The former, hoping to have long deferred expectations realized, held out extraordinary inducements to secure the contract but nevertheless it went to Fairfield, because the majority of the Board believed that the German yards could not give as trustworthy guarantee of reliable work as their British



TORPEDO BOAT SUSPENDED FROM CRANE.
("Weser" Shipbuilding Company, Bremen.)



PERSIAN STEAMSHIP "PERSEPOLIS."

(Built by the "Weser" Shipbuilding Company, Bremen, 1884.)

competitors. The Hamburg Company had not been quite as conservative and had ordered small vessels since 1873 from the yard of Blohm and Voss in Hamburg, from the North German yard in Kiel, and, in 1879, from the Flensburg shipyard. The urgent request of the Minister of Marine von Stosch was however necessary to induce the Board to give the orders for the two largest passenger steamers built in Germany before 1882, the *Rugia* and the *Rhätia*; the first to the "Vulcan" at Stettin, and the second to the Reiherstieg yard at Hamburg. Both orders were executed to the fullest satisfaction of the Board, but the ice was only really broken in 1886 and 1887 when the "Vulcan" at Stettin, delivered to the North German Lloyd in Bremen six imperial mail steamers, subsidized by the government for trips to Eastern Asia and Australia upon the express condition that they should be built at home and of German material. These steamers, which complied with all specifications, proved that in Germany shipbuilding had reached the same grade of excellence as in Great Britain, and from that time forward further orders were given by both of the two great transportatoin lines to the "Vulcan," as well as the other large yards, as that of Blohm and Voss, Reiherstieg and others.

Important triumphs had also been scored with the delivery by the

"Vulcan," of the battle-ships *Preussen*, *Sachsen* and *Württemberg*. The imperial navy yard had built the *Friedrich der Grosse* and the *Grosser Kurfürst*, sister ships of the first of the above mentioned vessels, and with the help of the Danzig yard also built the armoured vessels *Bayern* and *Baden*, *Hansa*, the cruiser *Alexandrine*, and others. The "Vulcan" built the corvettes *Leipzig*, *Prince Adelbert*, *Stosch*, *Stein*, *Carola* and *Olga*. In the "Germania" yard at Kiel, belonging to the Weser Company corvettes of the type of the *Bismarck*, small armoured vessels for coast defence, the imperial yacht *Hohenzollern*, and others were built. Schichau at Elbing was specially distin-



STEAMSHIP "AUSTRALIA," 3,000 TONS BURDEN.

(Built by the "Weser" Shipbuilding Company, Bremen, 1884.)

guished for light and rapid torpedo boats, and the knowledge and experience gained by the managers, designers, engineers and workmen of the private yards in executing all these orders for different kinds of steam craft were recognized by foreign governments, so that on every side foreign orders for battle ships poured into the German yards.

China ordered of the "Vulcan" two armoured vessels and three protected, partly armoured cruisers, besides many torpedo boats. Russia ordered from the Weser Company two small cruisers. Spain ordered a torpedo boat. The Germania Company obtained contracts and built men-of-war for Turkey, Spain and Brazil. The Schichau yard received many orders for torpedo boats from many foreign gov-



LIGHTSHIP BUILT BY THE "WESER" SHIPBUILDING COMPANY, BREMEN.

ernments of Europe, Asia and America and the Howaldt yards at Kiel built two cruisers for China.

The latest German products of shipbuilding are in every respect, both in design, construction, quality of material and perfection of work equal to the very best done in British, American and French yards.

The best proof of this is the fact that in addition to renewed orders from the foreign governments who had already favored German yards, other governments like Russia and Japan, who thus far had ordered nothing larger than torpedo boats now began to order battle-ships. Through the satisfactory filling of these orders the good work goes on, yet the very highest pinnacle of success and fame was reached in the fast steamer *Kaiser Wilhelm der Grosse*, which now, for more than a year, without long trial trip and without interruption, has made steady runs between Bremen and New York with the highest record of speed ever reached by this class of vessel. With the single exception of the *Great Eastern* it surpasses in size any steamer ever launched, and even greater results are expected from the *Deutschland* now building at "Vulcan," although the recently-launched *Oceanic* at Belfast surpasses it in dimensions.

MACHINE-SHOP MANAGEMENT IN EUROPE AND AMERICA.

By H. F. L. Orcutt.

VIII.—ELEMENTS OF A MODERN MACHINE SHOP (Concluded).

IN concluding the discussion of the requirements of a modern machine shop, the enumeration of the essential elements will be completed and some general conclusions drawn.

Foundry. This is, of course, a distinct organization in itself, and it will be mentioned only as a desirable adjunct to a machine shop which is large enough to support its own foundry. The importance of a thorough control of the foundry, with a view to producing castings of such a quality that work will be saved in the shop and the cost of machining and tools will be reduced as much as possible, is now fully appreciated by most machine-tool makers. Europeans, however, must pay far more attention to their foundry practice than at present, in the way of turning out more accurate castings, pickling, annealing, using the right raw material, etc., before they can compete either in price or quality with the castings usually found in the American machine tool.

Laboratory. It is remarkable what a long-suffering victim the machine shop has been simply because it has not made use of any scientific methods to check the mysterious workings of iron and steel makers. The laboratory should be an auxiliary to the machine shop, the value of which is, I believe, not yet recognized by any machine tool maker, either European or American. It is, however, to be thoroughly tried by the Loewe company, who are fitting up a laboratory adapted to machine shop requirements, for the chemical and physical testing of all materials which enter into the construction of a machine tool. The results will be watched with interest by all machine-tool makers, and it is hoped that the laboratory will be of use in determining the exact specifications of material, particularly of that used in cutting-tools.

It will be noted that the production of small tools, which is undertaken by many machine-tool makers, has received no consideration in the arrangement here set forth. The fact is that practically the same organization is necessary for the manufacture of small tools as for machinery, with the difference that the parts can, in most cases, be produced in larger quantities, and, of course, the machinery and tools

are materially different. At the same time, they are not, as a rule, made in sufficient numbers to warrant a special plant for the production of each article like a reamer, counterbore, tap, die, etc. Nearly the same departments would be necessary as for making machine-tools, but the work is so entirely different that it is out of the question to combine it with the production of machinery. The methods which should be followed would largely depend, of course, on the size of the works. In any case, a special department should be arranged devoted wholly to the production of small tools, whether on a large or a small scale. If on a large scale, a special factory building with separate engineer's organization and plant would be desirable.

It would be impossible, in the limits of the present article, to enumerate the best appliances and machines to be used in the departments mentioned, or to speak of the designs of the various fixtures and fittings. It is possible to arrange most of these departments even in the older factories not specially designed with a view to this particular organization, although, of course, it would be more difficult to produce machines as cheaply in such works as where the design of the buildings or factories harmonized with the organization described. As many other factors are necessary for consideration in arranging a modern machine shop, apart from the organization and equipment, it would be well to state briefly other items which should receive particular attention, such as

1. Method of transmitting power.
2. Transportation of parts.
3. Flooring.
4. Heating, ventilating and lighting.
5. Accommodation for workmen.
6. General fittings.

Transmission of Power. Within the scope of this paper it is not possible to discuss the economy of any system of transmitting power. It is generally admitted, by those who have had occasion to design shops within the last few years, that electric transmission has immense advantages over any other method. In many cases, separate machines can be arranged with independent motors. Groups of machines, run by one motor, operated quite independently of the rest of the factory can also be arranged. Large driving belts, which take up factory space, and are always a source of annoyance and expense, are thus done away with, but the greatest advantage of all is where entirely new works have to be designed. In this case electric transmission adapts itself to any form of building whatever, or to any group of buildings which may be deemed advisable. It is also possible, where electric

drive is properly installed, to take exact readings of power consumed in individual cases. For some of the above reasons, the electric transmission of power is largely in favour. Respecting other details of transmission, the proper form of hangers and bearings, and sizes and speeds of shafts are worth careful consideration to any manufacturer, as the amount of power consumed by a badly arranged transmission can never be accurately calculated. Roller bearings are the latest innovation for the saving of power, and remarkable results in transmission have been obtained in some cases by their adoption. Now-a-days no one would think of putting in anything but self-oiling and self-aligning bearings. Particular attention should be given to a practical method of securing countershafts and main shaft hangers, on account both of the saving in erection and of the changes constantly occurring in the location of machines.

Transportation of Parts. With respect to the above items, the old factories are at a decided disadvantage compared with the newly arranged machine shops. For the transportation of parts is a serious consideration to any manufacturer who must continually handle heavy pieces of metal. The appliances and labour-saving devices are numerous, and they have received far less consideration from machine tool makers, either American or European, than from manufacturers of other articles. I know of no machine shop which is perfectly equipped with reference to the transportation of parts. Some of the elements that should receive consideration in this department may be here enumerated. Electric traveling cranes, running at high speeds, are, of course, an important factor. Quickly operating hoists on runners or hand cranes are also extensively used; the air hoist seems to be the most economical for this class of work, although few old factories can avail themselves of its use, as considerable height is necessary for the simplest working form of air hoist. That which is most seriously neglected in transportation of material, however, is, what may be termed the industrial railway, which is so thoroughly developed by the C. W. Hunt Co., New York. By an extensive system of factory rails, with properly designed trucks, immense savings can be effected. One man should be able to convey to any part of the works weights or loads up to a ton, but where there are no special facilities, four or five men would be necessary to transport the same load. As a labour-saving device, this internal railway receives far too little attention from manufacturers..

Flooring. An item that has received careful attention from American machine shop constructors but seems to be looked upon by

Europeans as merely a structure for supporting loads. It seems that in Europe the design of machine-shop floors is usually left to architects who have no appreciation whatever of mechanical requirements. To make a floor which is true—so that machines can be easily levelled up and will remain in alignment,—to which light machinery can be easily fastened, which is cheap to repair, which is kept clean easily, and still is not dusty, which is not affected by oil, is durable, warm and not too expensive, is possible. The desirability of fulfilling the above conditions cannot be disputed, but this is not realized in European shops. Proper flooring is, however, one of the essentials in machine shop equipment which is of material assistance in producing good machinery; it is a valuable aid in maintaining order and cleanliness.

Heating, Ventilating and Lighting. To secure the greatest comfort and the best surroundings for workmen is, as almost every manufacturer will admit, a paying investment; at the same time, the practical value of these accessories is scarcely ever fully realized. They receive far more attention in America than in European countries. The health of workmen is of first importance, and by the absence of discomforting and distracting surroundings their efficiency is increased. Will any manufacturer contend that good work can be produced for a reasonable price in dark, cold and badly ventilated shops? Lofty, well lighted, comfortably heated and ventilated workshops, then, are important factors in the production of a machine tool. Heating alone is an important item, and a well heated factory can be easily and cheaply equipped if a proper system is installed. It seems that there is no system which meets the requirements of a manufacturing establishment so fully as that of the forced warm air blast, such as has been developed by the Sturtevant Engineering Co. and others. Its advantages are absolute control, ease of manipulation, it is thoroughly effectual and gives the best of ventilation, as the fresh heated air can be steadily supplied in the cold weather and a constant stream of fresh air can be introduced into the various departments in the hot weather.

Electric light, in various forms, is rapidly displacing all other methods for factory purposes; it is much safer, more easily manipulated, and does not pollute the atmosphere like gas. In order to secure all the daylight possible, windows must be large, rooms must be of the right height and width with reference to surrounding buildings, and, where top light is used, there must be plenty of glass surface. Ribbed glass is very satisfactory as a means of diffusing light; it has many advantages, and is sure to be widely adopted.

Accommodation for Workmen. As a means of securing and retaining the best workmen, the best appliances for their accommodation and comfort become, of course, a necessity. To maintain order, cleanliness and discipline is impossible with inferior arrangements for the personal comfort of workmen. It is hardly reasonable to expect a high state of efficiency in a combined machine shop, wash room, wardrobe and eating house; this is the combination found in the ordinary machine shop. It is an uneconomical use of shop space to occupy it with wash basins and clothes cupboards. To give the best accommodation to workmen, and to secure the best shop organization, necessitates the separation of everything pertaining to the personal wants of employees from that which has to do purely with manufacturing. Closets can be arranged so as not to encroach on shop space and still be convenient; it goes without saying that they should be well fitted and so designed that they can easily be kept clean and under control. The advantages of having good cellars (not to be used as work rooms) under a machine shop are so numerous that they need not be enumerated. The most important use for cellar space is, undoubtedly, for commodious washing facilities, combined with wardrobes. From no other point can men so quickly reach all departments as from the cellar. The moral influences of good accommodation in the above respects are valuable, as these comforts are inducements which assist in retaining desirable and in weeding out indifferent men. As far as I know, no machine shop has tried the experiment of supporting a restaurant, and of giving the men a good mid-day meal, free of cost to the employees. I am strongly of the opinion that free dinners would be a paying institution. In European shops where the standard of living is, amongst employees, lower than in America, a good dinner could easily be supplied at a cost of six pence, or fifty pfennigs per head. If free, this would be equivalent to increasing the pay of each man by the cost of the meal, with the certainty that that portion of his wages was used for the material welfare both of himself and of his employer, and was not devoted to beer, which does not nourish but incapacitates. To a machine shop of any considerable size, I look upon a restaurant as an element worthy of consideration.

General Fittings This would include all factory fittings which facilitate the handling and control of work that is in process, and the distribution and care of tools and fixtures. Tool rooms should be well arranged, and located conveniently for the distribution of supplies. Benches, racks and cabinets should be properly designed and

situated. This item, if it receives due attention, will be found complicated and extensive. It has an important bearing, if order, cleanliness, and good organization are desirable.

It finally remains to mention accounting and cost keeping as the one element which unites all others into a complete organism. Its object is twofold: to maintain orderly progress in the process of manufacture, and to record information which is exact and easy of access. As such it is of material importance in keeping up a standard of excellence, and in reducing the cost of manufacturing. It is more generally made use of, and is more thoroughly developed in America than in Europe. This subject has been exhaustively and interestingly discussed by Mr. Roland in recent numbers of *THE ENGINEERING MAGAZINE*.

It will be seen that the various items have been but briefly dealt with. In planning a new machine shop, or in re-organizing an old one, all the elements which have been enumerated must be dealt with, whether the shop be large or small. How they should be grouped, expanded or contracted depends upon the size of the factory, and the variety and character of the product. The ideal to follow is to have the product continually moving in one direction—going in at one end of the building in a raw state and coming out at the other as a finished article. This principle, if followed, admits of systematic organization, and reduces the cost of transportation to a minimum. In designing a building for a modern machine shop, the building itself may be considered as the frame work of a large machine, in which all the smaller parts are to work. Architectural design must simply follow the dictates of engineering requirements. But a brief outline can be here given of those items which should receive particular consideration in planning entirely new works. First and foremost, it should not be forgotten that each department must be a specialty in itself, as far as possible, with special equipment, special foremen and trained workmen who are, in a measure, entirely independent of any other department. This is but the sub-division of labour, and in order to get the full benefit of specialization, it will be found that the best plan is to have departments entirely separated from each other, and to have as little communication between the workmen of the various departments as practicable. The form of building should be such that, having due regard to other conditions, the proper divisions are possible. It would appear that the wing construction best fulfils the above requirements, as it gives the best light while taking up the least space. It seems entirely unnecessary for machine-shop work to go to the ex-

treme of having everything on one floor, except where heavy machines exclusively are made, as it is highly desirable for a great deal of machine work to have side lights. For the transportation of heavy parts, overhead cranes necessitate a peculiar form of construction, but this can be readily combined with the wing design, so that the transportation can be easily carried on.

The manufacturer who seeks to satisfy his customer with speedy deliveries will not fail, in planning new works, to give due consideration to shipping facilities. Here the system of transportation should receive its final touch. Economy and dispatch are a satisfaction to all concerned in handling the finished product of the modern machine shop.

First, last and always, should manufacturers, especially those who are to erect new shops, remember that it is economy as well as humanity to plan factories "in which human life is of more account than machinery"; into which human beings will not be driven by hunger, but attracted by superior hygienic surroundings, air, light, comfort, as well as by the most modern equipments for saving labour, increasing output and raising the standard of workmanship and wages. Specialization is an economic necessity. How to mitigate the incapacitating effects of routine work is one of the coming industrial problems. The least that capital can do at present towards solving this problem is to erect rational workshops.

THE ENGINEER AND THE ROAD TO THE GOLD FIELDS.

By Harrington Emerson.

HE who leaves Seattle for the Klondike and the Alaskan gold fields, enters another world when he boards the north-bound steamer. It is not that the vessel differs from steamers of the same tonnage on the Atlantic Coast, for the engineer's handiwork must be more perfect for voyages to the outlying places of the earth where there are no repair shops. It is the passengers who make a different world, or perhaps it is fairer to say that among them the conventions of civilized life lose their force, and the sordidness and other elemental and unlovely instincts which civilization hides but does not eradicate, crop up unblushingly.

A good part of the men northward bound are miners, animated not by patriotism nor hope of homestead, not by dream of glory nor love of science, not by pride of conquest nor religious enthusiasm, not even by the pleasure of adventure, but impelled northwards solely by lust of gold. Dogging the footsteps of these pioneers is the motley horde of human parasites and beasts of prey, both male and female, and these and their ways emphasize the difference between the lust for gold and the pursuit of immaterial riches. No one tries to rob Dewey of his laurels nor Nansen of the honor due his adventures and discoveries, but if a man has secured an ounce of gold a thousand rise up in his path and try to take it away from him.

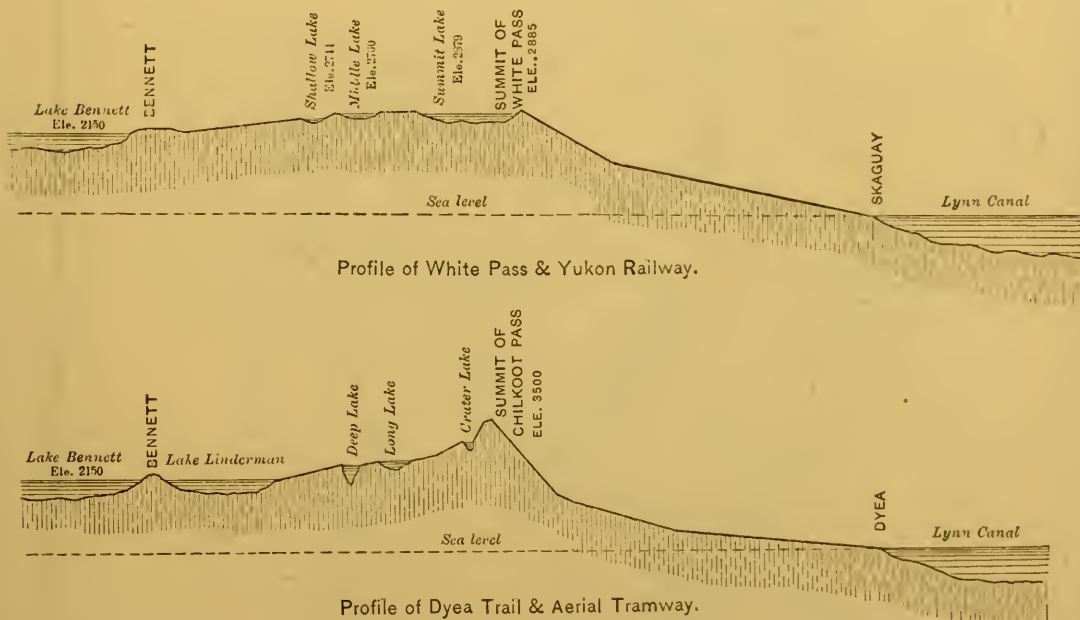
Owing to the absence of parasites, industrial, criminal, and governmental, it was cheaper and safer to go to the Yukon ten years ago than it was when the great work was on, and were it not for the works of the engineer, the passage down or up the Yukon would to-day be lined with as many robber roosts, levying blackmail, euphemiously called toll, on all the travel and traffic, as was the Rhine in the Middle Ages.

But the engineer, with his ocean steamers, wharves, railroads, aerial cableways, riverboats, etc., came and converted what was once an expedition of extreme physical danger and hardship, and what next became a journey of extreme pecuniary danger and expense, into a rapid, safe, convenient and also cheap trip to the Arctic Circle. It is this cheapness that above all else will develop the resources of that

far off region, making profitable great numbers of mines to-day unworkable.

In California, gravels containing as little as five cents of gold to the cubic yard are washed at a profit, but in the Klondike region all gravel that yields less than fifteen dollars per cubic yard is mined at a loss. It is too much to expect that far northern gravels can ever be worked as cheaply as in California, but it is not too much to expect that with cheaper labor, cheaper supplies, and above all, better appliances, five dollar gravels will in time have value.

The most remarkable part of the long road to the new gold fields is the short link which crosses the backbone of the continent. Else-

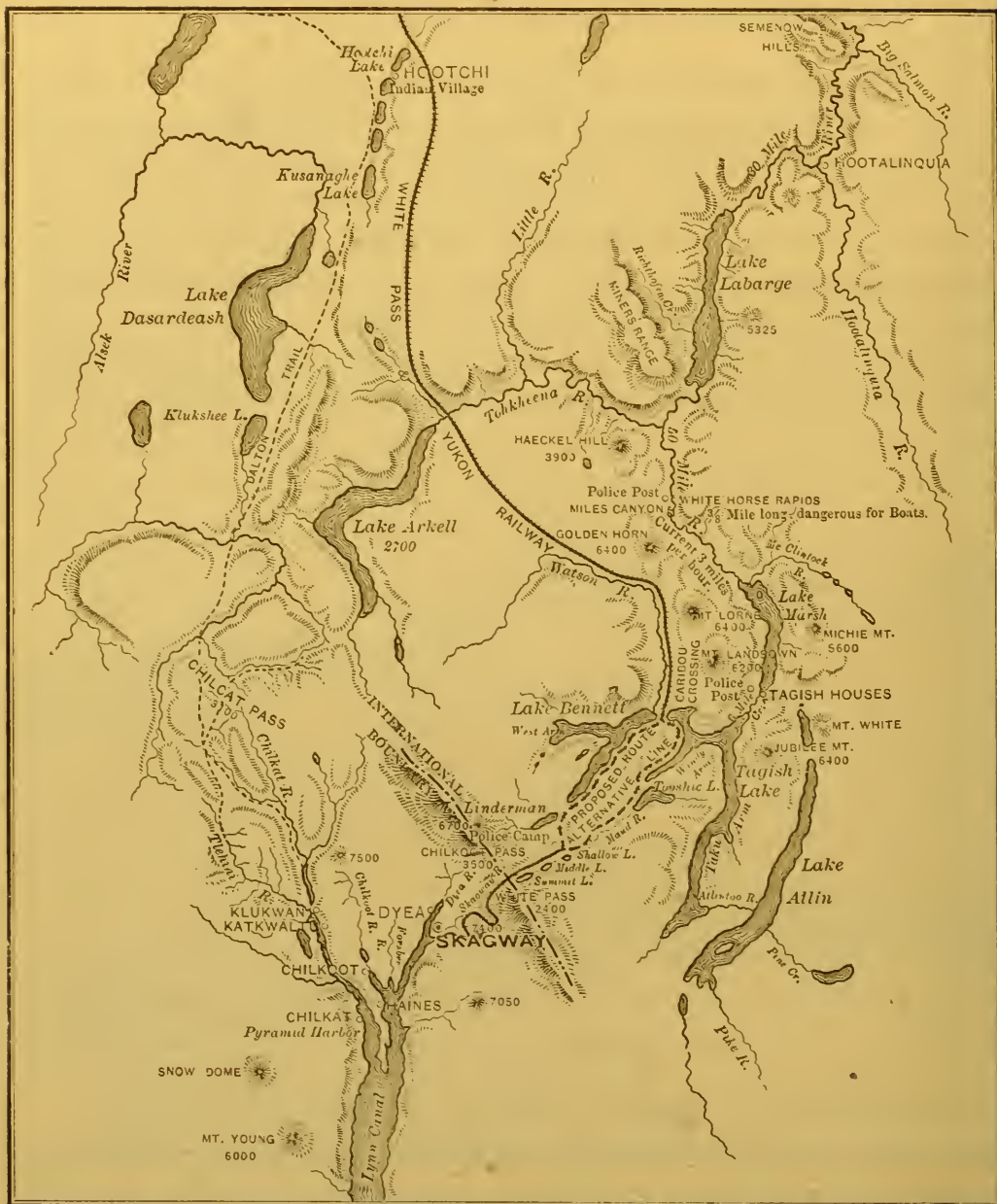


PROFILES OF THE TWO ROUTES FROM LYNN CANAL TO LAKE BENNETT.

where, the continental divide lies in Colorado, Wyoming, Idaho, but in southeastern Alaska, it is a rampart rising direct from the sea. At its base lie the blue waters of an arm of the Pacific. Fourteen miles inland is the summit and immediately beyond are the head waters of the Yukon. A few coast passes are the only feasible highroads to the interior, and this gives them very great political as well as commercial importance. Further north between the Yukon and the ocean are those stupendous snow giants Mount Saint Elias and Mount Logan, towering above 18,000 feet in height.

The profiles showing the two lowest passes from ocean to river were drawn from his own surveys by Frank Reid the engineer, who, at Skagway, Alaska, in 1898, in the cause of decency, order and law,

THE ROAD TO THE GOLD FIELDS.

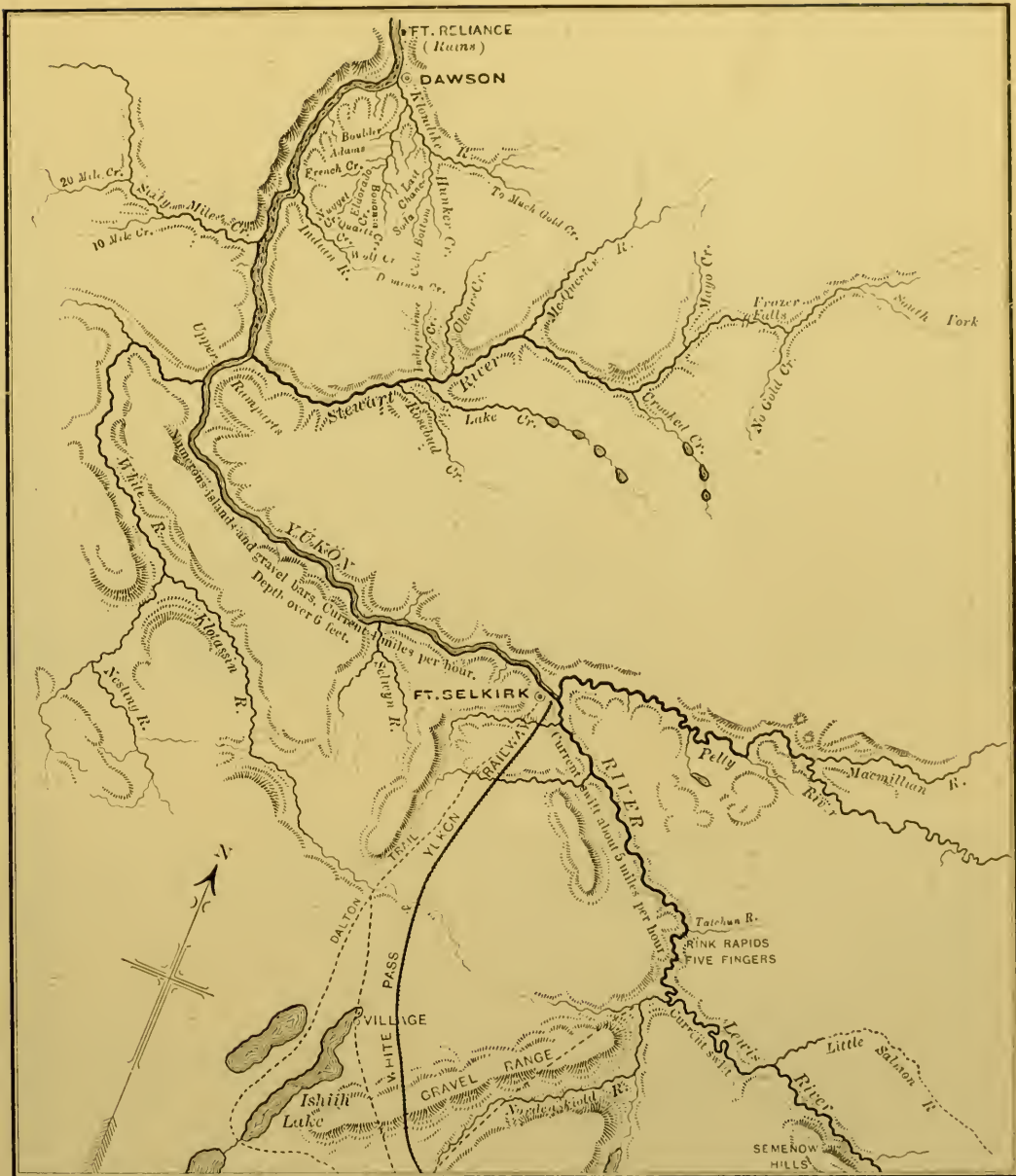


ROUTE OF WHITE PASS AND YUKON RAILWAY FROM SKAGWAY TO FORT SELKIRK.
(Part I., from Lynn Canal to Semenow Hills.)

shot and killed "Soapy Smith," the leader of all the crooks and thugs with which the place was infested, and was in turn killed by him.

Of all the many dead claimed by the dangers and diseases of the murderous trails, Frank Reid alone rests under an imposing monument, erected in the forlorn little cemetery to show the gratitude of the citizens and as a permanent warning to evil doers.

The *man* was honored who had saved the town from a reign of terror, but the *engineer* began a greater work in his surveys which



ROUTE OF THE WHITE PASS AND YUKON RAILWAY FROM SKAGWAY TO FORT SELKIRK.

(Part II, from Semenow Hills to Dawson.)

were the beginning of a development, that, in eighteen months replaced the Indian hunter's foot-path with aerial cableways and a steam railway.

The profiles are worth studying. Lynn Canal is an inlet or fjord of the Pacific Ocean, and the lakes over the summits are the head lakes of the Yukon River. Although these summits are but fourteen miles from the ocean, the distance down the Yukon to Bering Sea is two thousand miles. Nowhere else in the world are the navigable head waters of a great river so near the same ocean into which it finally



WHITE PASS ABOVE THE FORD.



AT THE FORD, SHOWING SUMMIT OF WHITE PASS.

empties. It is as if the headwaters of the Ohio River were but fourteen miles from New York Bay.

From Panama to the Fuca Straits there are but few harbors, but from Puget Sound northwards a whole coast system of mountains and valleys sank, in a former geologic age, several thousand feet, and thus formed the present sounds, canals, channels, inlets, bays, harbors, a land locked water-way of marvelous beauty—and danger—stretching a thousand miles north of the sound cities, Tacoma, Seattle, Victoria and Vancouver. So smooth and placid is this water-way that Indians, in their dugouts, undertake trips of one thousand and more miles along the coast, yet so dangerous is it that scarcely a week passes without some steamer striking or stranding on the dark shores or sunken rocks. At the northern end of this inside passage and ninety miles from the sea is the head of Lynn Canal, which is seven miles wide and from 135 to 413 fathoms deep, but the Wrangel Narrows, a hundred miles further south, are only a quarter of a mile wide and eighteen miles long, and so shallow that rarely a steamer passes through them without scraping on the bottom. At another point in the long inside passage conflicting tide currents swirl and rush thirty miles an hour, and this place can only be passed at slack water, either high or low.

At the head of Lynn Canal is Dyea Inlet, fourteen miles long and but one mile wide, and into the head of Dyea Inlet empty the Dyea and Skagway Rivers, each making a long mud delta covered at high water, bare at low tide; and here the tidal range is very great, sixteen or more feet.

The Dyea and Skagway Rivers both flow rapidly down from the summits of the coast range of mountains. They are but torrents, only fourteen miles long from source to deltas, and within a few feet of their head waters are the head waters of the Yukon; thus natural passes are formed from the coast to the interior. By no other route is the distance so short as up the Dyea River. There has always been an Indian village at Dyea, which is doubly favored by being at the extreme head of ocean navigation and nearest to the series of lakes, Crater, Long and Deep, which empty directly into Lake Lindeman. This lake in turn empties into Lake Bennett, which is but forty miles from Dyea. From an engineering point of view the Skagway route is the better, as the White Pass at the head of the Skagway River is six hundred feet lower than the Chilkoot Pass, but neither Indians nor miners used it. Its series of lakes, Summit, Middle and Shallow, are separated from Lake Bennett by a high divide and flow by long and



THE AERIAL CABLEWAY OVER THE CHILKOOT PASS.

shallow streams into other lakes not so immediately available for reaching the Yukon.

Although the distance to Lake Bennett is the same by survey over each pass the most enthusiastic backers of the White Pass route have always considered it at least ten miles longer, owing to its extreme and lasting difficulty, for foot and horse travel.

In former years at two seasons of the year only was travel possible over the Chilkoot Pass, in late winter when the snow was hard and the lakes frozen, and in late summer when the lakes were open for rafts and canoes.

It is strange that this easy and natural highway for the Indian up the coast in a canoe, over the pass with a pack on his back and down the river on a raft, should have presented almost insuperable obstacles to civilized travel. The Indian in his dugout cared not for narrows, shallows and currents, tides and flats. He did not try to force them but accommodated himself to conditions as he found them, and was governed by the seasons in his trips over the pass, as was also the early gold seeker, who, drifting north in 1877, made his way with Indian help over the Chilkoot Pass to the Yukon River.

Between the final triumph of modern engineering, the railroad, and the natural highway of the savage, there were many stages of improvement which were more toilsome, dangerous and expensive than

the conditions they are supposed to better. There was no longer easy and sympathetic acquiescence in nature's whims when the great gold rush to the Yukon began in August, 1897.

Just as the engineer has substituted his works for all other instruments or vehicles of transportation over the White Pass, so also it is the engineer who with his ocean steamers has supplanted the Indian canoe, the sailboat, the little coast steamers, but with the difference that whereas the land engineer makes his own road on which he safely runs his engines, the naval engineer can only build a good steamer, which too often is wrecked owing to the culpable negligence of a government, quick enough to install revenue collectors, but exceedingly slow to chart, buoy and light dangerous channels.

Nearly five thousand people a month make the passage from Seattle and other Sound Cities to southeastern Alaska, and many thousand tons of freight are also carried, yet aside from a few buoys in Wrangel Narrows there is absolutely nothing provided by the government to aid the mariner in navigating those waters. The Canadian government, both on land and sea, is more prompt to act and to provide protection. It has a light-house on the Sister Rocks in the Gulf of Georgia, another at Cape Mudge at the entrance to Discovery Pas-



THE LAST CLIMB TO THE SUMMIT OF CHILKOOT PASS.

sage and yet another at Egg Island. The disastrous wrecks almost without exception have occurred in United States waters.

As canoes gave way to ocean-going vessels in these unbuoyed and unlighted channels, the government pilot charts were improved with pasters suggesting that the chart was not more than five miles out of the way. Steamer after steamer was lost, the Mexico sank in August, 1897, on her return trip from carrying the first load of gold seekers, the Corona stranded in November of the same year, the Clara Nevada ran on a rock and burned or blew up with a loss of all on board in the



SUNSET ON THE YUKON.

following February, and since then a dozen other steamers have either grounded or been totally wrecked. These dangers and losses continue to date. On February 15th, 1899, the Humboldt, a fine California steamer, went on the rocks between Juneau and Wrangel, and was in gravest danger; early in March the Dirigo stranded but was finally dragged off with severe damage; later in March the Tees, a Canadian steamer, was reported fast on the rocky Alaskan coast and on March 29th the City of Topeka of the Pacific Coast Steamship Company went fast on a ledge in Wrangel Narrows.

As the engineer was not able to take the survey and improvement of the sea highway out of the hands of the government he turned his attention to terminals for the carriers both by land and water which

his skill had evolved, and here also the transition from the perfectly safe landing of the Indian canoe on the flat beach above high water to the equally safe landing of the ocean steamer at a deep sea wharf, beyond the fall of the lowest tide, has been through intermediate steps expensive and dangerous.

The first load of gold seekers in August, 1897, found no wharves at Dyea or Skagway, and the hastily gathered mining outfits were either lightered ashore at great expense, or at low tide dumped off the steamers to be submerged by the returning waters unless rapidly



LOOKING DOWN THE YUKON BELOW DAWSON.

moved by wagons whose owners charged extortionate rates. Prices for packing over the pass had been twelve to fifteen cents a pound in the old days of Indian-back, but they rapidly rose to forty-seven cents by the Dyea or Chilkoot trail and to sixty cents by the Skagway trail. Blockades occurred, paths turned into bottomless pits and pandemonium was everywhere.

It is a curious illustration of the fallibility of intelligent human judgment that nearly all the capitalists organized transportation companies to reach the Klondike by way of the mouth of the Yukon, leaving the nearer and obvious road in the hands of men without capital but with plenty of energy and ready quickness.

THE ROAD TO THE GOLD FIELDS.

A comparison of the two routes to Dawson, down and up the river, should have been sufficient to convince one as to their relative values. Dawson is sixteen hundred miles from the Sound Cities. Of this distance one thousand miles are by inland sea, forty are by mountain pass, the balance down lakes and rivers. This route is open eight months in the year. By the other route it is over four thousand miles to Dawson, twenty-seven hundred miles of North Pacific Ocean to St. Michaels, and about fifteen hundred miles of treacherous river touching the Arctic circle with bars at mouth and elsewhere. Boats are limited to a three foot draft, and the river mouth is open but three months in the year.

The extent of the transportation delusion is evidenced by the increase of steamboats on the lower Yukon from scarce a dozen in 1897 to one hundred and ten by the summer of 1898. These boats represented capital. The gold seekers went the other way and the only real rivalry that there has ever been for a permanent Yukon route is between Dyea and Skagway, between the Chilkoot and White Passes. When the rush began, one of these was an Indian path, the other nothing, but, what it lacked in merit Skagway made up in boisterous advertising. The Indian village at Dyea developed into a town, the



THE MUD FLATS AT SKAGWAY.

(The railway runs along under the bank beyond the left wharf.)



THE WHITE HORSE RAPIDS.

American speculation on the Skagway flats was platted and the City of Skagway started. It first succeeded in building a wharf to deep water and this was the beginning of its supremacy, because it became easier and safer to land there. Beyond the landing this trail was utterly unfit for travel, but the first arrivals were too busy pushing on to warn those who might follow, and both town boomers and steamer lines assured ticket buyers that whatever might have been true last week, *now* the trail was indeed open.

Above its delta, the Skagway River, a mountain torrent, occupies nearly the whole width of the valley. The mountains rise steeply on each side and every spot that is not washed bare of earth is overgrown with heavy timber. If, in rare places the river has a shore, it is covered with boulders and loose rock, either terminal or lateral moraines of the former Skagway glacier, or the result of landslides. For ten miles from the sea, the fall of the Skagway River is not rapid but above the last fork, the stream rushing down from the summit of the White Pass is a rocky torrent, in a deep cañon bed. The rise in the last four miles below the divide is about 2,000 feet.

Illustrations, better than description, show the characteristics of the route from Lynn Canal to the white summit.

Over twelve thousand people landed at Skagway in the first year

after the rush, or between August, 1897 and July, 1898. Most of these unfortunates crossed the pass dozens of times carrying their goods in relays, a man load at a time, a slow way of transporting a ton or two of supplies a distance of thirty miles over almost impassable trails. Most of the packing was done on man back and extraordinary loads were carried.

One of the Indians on Chilkoot carried in one load 247 pounds over the summit, and on the whole, nothing is so generally efficient as a man. Dogs were fitted with pack saddles and given loads of ten to thirty pounds, and this was worth while, at sixty cents a pound. Goats were used, rafts, canoes, rough boats, any and everything that could be impressed into service.

Horses were shipped to Skagway by the hundred, and there, on the worst trail in the world, they died also by hundreds, but during this first summer a horse was not able to carry as much as a man.

It was the packers, the owners of the horse trains who made the first trail, for the gold seekers had no time to join in any "good road movement," but the packers organized, instituted compulsory service and by the spring of 1898 had succeeded in opening a very fair bridle path, making this trail from this time on essentially a horse trail, and thus scoring a second triumph over Dyea. The horses between Skagway and Bennett each carried 250 pounds besides feed for the round trip of four days. Six to seven horses or mules made a string under the care of one man, the driver riding on an extra animal, sometimes in front, often behind. Rates for packing fell to twenty and then to twelve cents a pound and fortunes were made, and squandered, in the business. Six horses carry fifteen hundred pounds of net freight and earn gross \$180 to \$300. Expenses for a round trip were \$40 in wages, \$12 hotel bills, \$25 for horse feed, \$20 wear and tear and \$15 toll, making a total of \$112. Some packers who had forty to fifty horses on the trail put in their own boarding camps, thus reducing expenses and the most energetic and successful and reliable earned for several months over \$1,000 a day net on an investment of \$2,000 to \$3,000. One energetic man interviewed the arriving Klondikers at Seattle, contracted to deliver their freight at Bennett, required a part payment in cash, used the cash to buy his horses and pack-saddles and went north on the same steamer with his customers and fulfilled his contract.

But the enormous amount of freight going to Dawson by way of the passes, nearly 20,000 tons, prompted Mr. George M. Brackett, an experienced and energetic railroad contractor, to begin a wagon road

from Skagway to the summit. He started early in the fall of 1897 and pushed the work with great energy, hoping to be ready for the great spring rush, but in this he was disappointed. The remoteness of the region, with mails ten days apart, labor, climatic and financial difficulties all combined to prevent rapid work. Nevertheless Mr. Brackett succeeded in building an excellent road for about ten miles, marring it however, and from an engineering point of view ruining it, by the fearful grade over Porcupine Hill, a grade so steep that two horses with a single sled loaded with only 400 pounds could scarcely climb it coming towards Skagway. Going down this same hill sled



HORSE TEAM FROM SKAGWAY TO LAKE BENNETT.

(One horse could make the round trip in three days, carrying 1,000 pounds.

runners are generally wrapped with heavy chains, in addition to the very effective automatic brakes used on all Skagway sleds. This brake consists of two sharp steel prongs bolted underneath the back end of the shafts and pointing downwards. When the horse pulls these are lifted off the ground or snow, but when on a down grade, the sled runs forward on to the shafts and presses the prongs deep into the ice or snow. Another effective form of brake is a dragging hook, bolted loosely through the back end of the runners. Ordinarily it is turned up and rests on top of the runner, but on down grades it is turned down so that the sharp end of the hook sticks into the runners'



AT WORK ON ROAD, 6 MILES FROM SKAGWAY.

track. On this hook the driver will stand, and thus hold almost any load.

On January 20th, 1899, a four horse double bob sled, not being equipped with these brakes, rushed the teams down the steep grade of Porcupine Hill and forced the leaders over the precipice, several hundred feet to the river below.

Mr. Brackett had built his wagon road without authority and there was indeed no time to wait for it, as the United States Government is always several years behind requirements in frontier matters. Very great friction developed between the wagon road company and the packers. The latter drove their pack horses up the frozen bed of the river and thus avoided the new road, but Brackett completed a short piece of road around which it was impossible to go and there he erected his first toll gate. While the struggle was going on in Alaska Brackett was not idle in Washington and secured the passage of a resolution by Congress giving the Secretary of the Interior jurisdiction over Alaskan roads with authority to grant toll privileges. From the Secretary of the Interior Brackett obtained authority to levy a toll of two cents a pound on all freight, ten dollars on each wagon, one dollar on each foot passenger, horse, sheep, dog or other animal. These rates were excessive. This wagon road owing to its heavy

grades was none of the best. In building it Mr. Brackett had in many places simply improved the previously existing trail made by the packers themselves. The road was only built for eleven miles, yet without proper investigation, without any comprehension of the actual conditions or of the equities, the privilege was granted to levy prohibitive tolls on all the enormous traffic using this pass. There was not even any possibility of appeal, as no court had any jurisdiction over tolls placed by act of Congress at the discretion of the Secretary of the Interior.

The wagon road however experienced difficulties. The Chilkoot Pass route had not been idle, and from the first as a man pack route it had been preferred to the White Pass because shorter, with better approaches and with more direct water ways to the head of Yukon navigation.

The first improvement on this pass was made when a horse whim was anchored at the summit of Chilkoot, and by this means loads of over a ton could be hauled up on sleds, thus putting this route far ahead of the Skagway trail for heavy freight as well as for single loads. After the first season the horse gave way to a gasoline engine, his last act being to wind his own successor to the top. The gold seekers could drag their own loads on sleds to the foot of the summit,



WAGON ROAD THROUGH THE CUT-OFF.

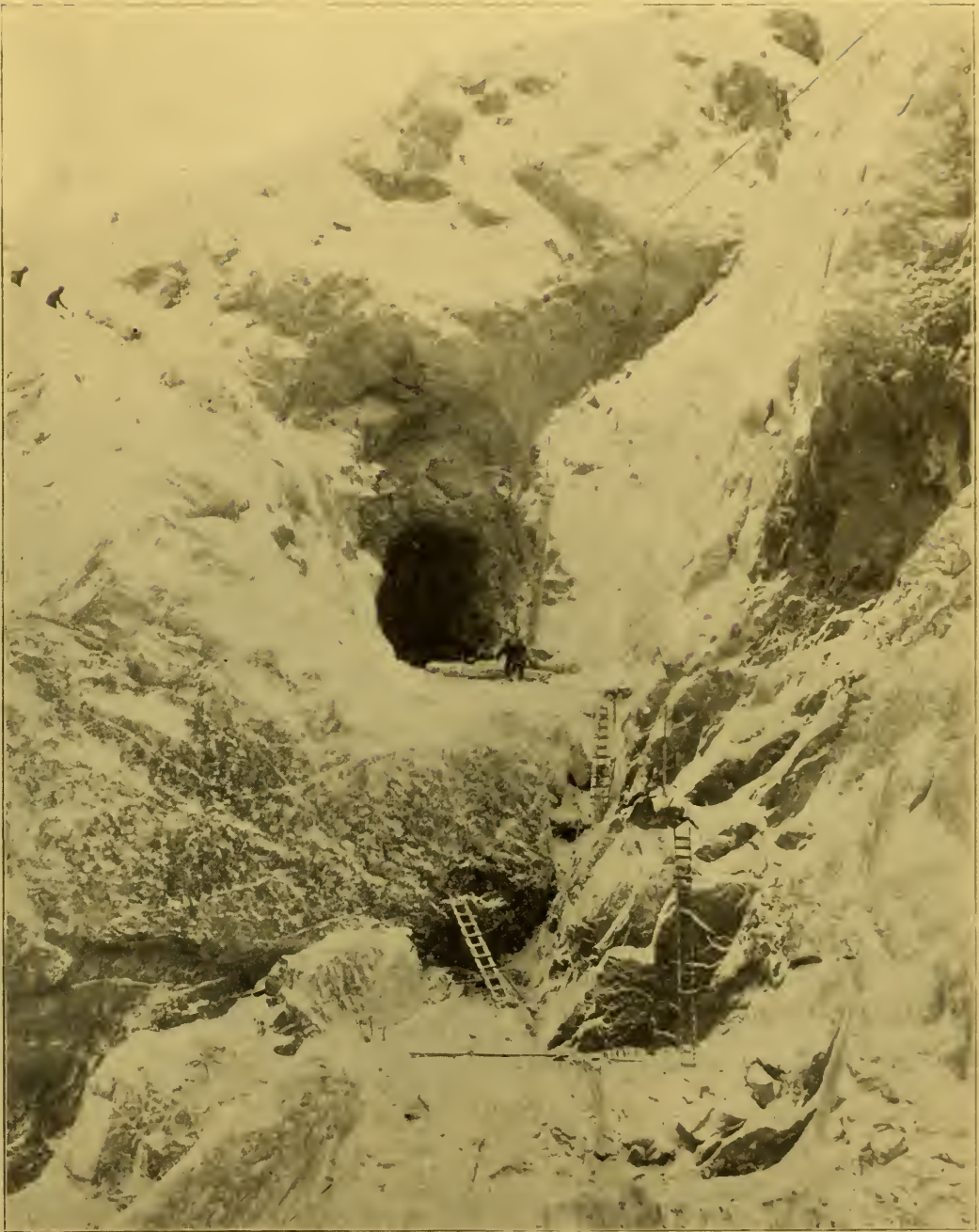
(Showing the road $3\frac{1}{2}$ miles from the summit of White Pass.)



CUTTING ROCK FOR GRADE ON TUNNEL MOUNTAIN. FISK'S CUT.

there turn them over to the whim, be hauled up, coast down the other side and go on their way rejoicing over the frozen lakes and smooth trail to Bennett..

As early as August, 1897, work was started on the Chilkoot Railroad and Transportation Company, on the Alaska Railroad and Transportation Company and on the Dyea Klondike Transportation Company, all three of them aerial cable trams. These three were ultimately consolidated into the Chilkoot Pass Route and but one line



TUNNEL ON THE WHITE PASS AND YUKON ROUTE.

finished in April, 1898. A large force of men was kept busy all winter, but very little beyond shovelling snow was accomplished from December 10th, 1897, to March 15th, 1898.

Two illustrations show transportation over the Chilkoot, one a March scene, men packing, the whim dragging a heavily loaded sled, the wires overhead; the other a midsummer scene, with a Peterboro canoe swung in mid air. This tram begins nine miles from Dyea at

Cañon City, to which place a wagon road is almost without grade. There are two loops, one from Cañon City to Sheep Camp, four miles, and the other from Sheep Camp over the summit and one quarter mile down the other side. This loop is four and one-quarter miles long. The trolley automatically switches from one loop to the other, and the load is limited to four hundred pounds, generally carried in boxes 40 x 20 x 24 inches.

With its level wagon road and these trams in operation the Dyea trail should and could have beaten its rival Skagway as to rates, but it could not handle the freight offered, and there were long delays.



PASSENGER TRAIN LEAVING SKAGWAY FOR THE SUMMIT, FEBRUARY 20, 1899.

charges of favoritism, and enough freight was secured at the Skagway rates of eight cents and up to keep the trams busy, so no reduction was made.

It was nevertheless this Dyea competition which forced a reduction of tolls on the Brackett road from Skagway, the rate being lowered to one cent a pound from Skagway to summit and three-quarters of a cent a pound to those who made their way up the river bed. Some packers also threatened to build a new trail of their own, and one energetic man with over one hundred tons of freight to carry was bribed from so doing by a free pass for his stuff.

All these transportation, financial and competitive struggles were

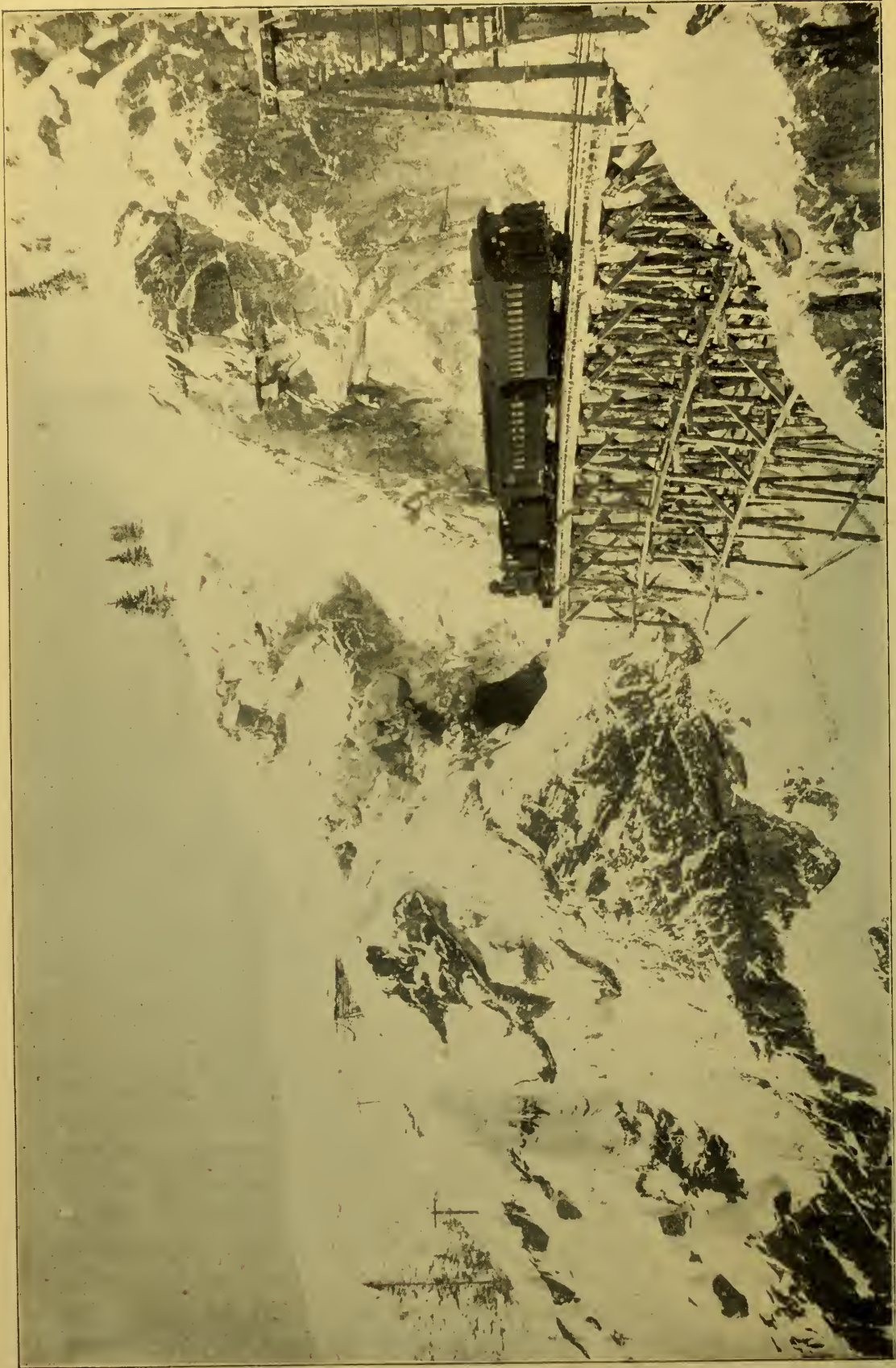
around and about the passes, the stretch from salt water to lakes. From the head of Lake Bennett down to Dawson, "over the ice" as it is called, the travel in winter is only by dog team, although this year one mule and one horse made the trip out. The Yukon sleds are sixteen inches wide, six feet long, eight inches high and strongly braced. Some are made with a gee pole on the right side, and the driver straddles the rope or chain by which the dogs pull. The preferred sled this year is the basket pattern with plow handles behind to which the driver clings. Four to eight dogs make a team. On a good



FIRST PASSENGER TRAIN OVER WHITE PASS AND YUKON ROUTE.

(Crossing east fork of Skagway River, February 20, 1899.)

smooth trail the native dogs, "insiders" as they are called, one-quarter, half or even three-quarters wolf, will drag one hundred pounds to the dog. These animals are thickly furred and seem to enjoy extreme cold. They are fed on boiled rice, corn meal and bacon, and will not eat dog biscuit. Outside dogs cannot stand the extreme cold, are not as a rule as good pullers and are miserably unhappy. At Skagway good insiders are worth from fifty to one hundred dollars; outside dogs can be bought for ten to twenty dollars. Up the White Pass and through fresh snow dogs cannot pull fifteen pounds. The extreme difficulties of the White Pass make a dog team trip from Dawson to



FIRST PASSENGER TRAIN ON THE WHITE PASS AND YUKON ROUTE TO THE SUMMIT, FEBRUARY 26, 1899.

Skagway much easier than from Skagway to Dawson, as the dogs are not worn out before they are fairly started.

The rapidity of travel with a good dog team is remarkable. Mr. Thomas Crahan left Dawson City January 28, 1899, at 9:45 o'clock, A.M., and reached Skagway February 12th at 4:45 P.M. He had two in his party and a four dog team to haul the equipments. While on the trail he fed his dogs once in the twenty-four hours, at night, each dog receiving two and a half pounds of food, which consisted of one and a half pounds of thoroughly boiled bacon, three-quarter pound



ARRIVAL OF FIRST PASSENGER TRAIN AT SUMMIT OF WHITE PASS.

(White Pass and Yukon Route, February 20, 1899.)

of well cooked rice and one quarter pound of cooked corn meal. The distance is full six hundred miles but although the dogs averaged more than forty miles a day they were in good condition.

On January 29th I turned over to M. A. Mahoney at Tagish 2,000 pounds of American and Canadian mails. He had four sleds with five fine dogs to each sled, and on each sled he loaded 500 pounds of mail or 100 pounds to each dog. He reached Dawson on February 26th. Returning he left Dawson March 21st at 9 o'clock A. M. with one passenger, the contract being to land him in Skagway in fourteen days, for \$700 or to forfeit \$100 for every day over that time. He

pulled into Skagway on the afternoon of March 31st at 5 o'clock, having made the trip in ten days and eight hours, or at the rate of fifty-five miles a day. The team consisted of six huskies (Arctic dogs), and he carried no supplies with him, buying everything for himself and dogs at the bunk houses along the river.

If a dog team has to carry its own food and that of the driver and thirty to forty pounds of blankets, robes and other equipments its radius of travel is very limited. Mahoney's teams could barely have



PASSENGER TRAIN COMING DOWN FROM SUMMIT.

(White Pass and Yukon Route, February 20, 1899.)

reached Dawson carrying their own supplies and no extra freight whatever. It is because there is no food for horses along the trail that these animals or mules are not used. A good horse can drag about two thousand pounds over a fair trail on a food allowance of forty pounds a day. He can travel through fresh snow that would stall any dog team, but the latter can travel over crusted snow that would break under horses. Wherever the food supply permits freighting is done with horses and mule teams, as between Skagway and Tagish one hundred miles towards Dawson, but for light and rapid



DOG TEAM WITH "OUTSIDE" DOGS

running from place to place dogs are preferred. Each dog is as much trouble to care for and more trouble to feed than a horse.

During the summer of 1898 pack trains were in full action over the White Pass and the trams over the Chilkoot, and the healthy rivalry between them prevented too great extortion. About this stage of development civilized modes of transportation may be said to have overtaken in convenience and cheapness the primitive savage methods. It was just about as cheap to send goods over in July, 1898 as in July,



DOG TEAM WITH "INSIDE" DOGS.

1897, before the rush had begun, but a new competitor now appeared in the field that was for all time to settle the supremacy of Skagway. This new comer was an international railroad, whose survey ran twenty miles through American territory from tide water at Skagway to the summit of the pass and the international boundary, and thence three hundred and twenty-five miles to Fort Selkirk, on the Yukon River, below White Horse Rapids and other dangers and but one hundred and seventy-four miles above Dawson.

This railroad is now in operation to the summit of the White Pass and much of the grading is done for twenty miles more to Lake Bennett. If it should stop here the aerial tram could still prove a dangerous rival, because the capital charges are so much less, operating expenses less, and its capacity could be easily increased to one hundred tons a day. The difficulty has been, not in transporting but in handling the freight at the two termini, where accumulations almost inextricable confusion and long delays.

Freight rates from Dyea to Bennett by way of the tram are, in March, 1899, three cents and a half a pound, and the same by the railroad. From the summit the railroad company has opened one of the best snow roads in the world. It was made by sending team after team through the snow drifts, packing down the snow until the hard bed rose above the level of the snow field and was thus swept clear by the wind. It is staked with saplings on both sides and can be followed in the darkest night or severest storm. Log Cabin, the custom house and mounted police station, is twelve miles from the summit and boundary, and is also at the end of the White Pass series of lakes, Summit, Middle and Shallow. The former trail from Log Cabin to Bennett was difficult both winter and summer, as it passed over a high and rocky divide, winding steeply up and down along the slopes. The new railroad trail was opened by cutting down trees, grubbing out stumps, blasting away boulders, packing down snow drifts, and is a beautiful and model road.

Freight carried to the summit by the railroad is there transferred to double bob four-horse sleds with wide runners and each such sled can be loaded with half a ton. Three or four of the freighting firms have formed a through freight line in connection with the railroad and through bills of lading are issued. A big freighters' camp is established near Log Cabin half way between the summit and Bennett and each morning except Sunday (for the mounted police will not allow freighting on Sunday), teams start in both directions, thus giving the horses ten miles of load down grade, and ten miles empty.

The railroad hauls to the summit of the pass for one cent a pound or one-half of the toll authorized by Secretary Bliss for the privilege of dragging one's own freight over the toll road. The freighters carry for two cents a pound from the summit to Bennett. The expenses of the round trip are about \$20; receipts under best conditions, which are the exception, may amount to \$200. If there were a sufficient quantity of freight there would be a bonanza in the business for a freighter with ten or more four-horse teams. As it is, the freighters alternate between excessive earnings and inability to pay their teamsters or other bills, none of them being organizations with large capital. The snow trail is not in good condition until February and begins to soften the latter part of April. The lakes are deep and well warmed during the long summer days, but in early winter the first sharp frost covers them with a thin crust of ice. On this a blanket of snow falls, which delays further freezing and presses the thin ice below the water, so that beneath the snow there is oftentimes slush two or three feet deep. Horses and men break through the upper snow, and the resulting wetting is dangerous with the thermometer 20° or more below zero and the wind blowing.

The railroad is a great example of engineering and constructive skill. It would have been a great feat to grade forty miles and build twenty over a similar rocky pass under the most favorable conditions, but this work was done in seven months, in a region without laborers, one thousand miles from supplies, three to four thousand miles from rolling mills and car shops, and against fearful climatic conditions. Day after day fresh snow drifted over the road bed and day after day it had to be shovelled off, sometimes to a depth of six to eight feet. Supplies, bridge timbers, fire wood even, for the enormous camps had to be carried over almost impassable snow trails. There were days when men could not work on account of the storms or the intense cold, but they had to be fed and warmed.

The road begins on deep water, a mile from Skagway. A shelf is blasted along the face of the cliff, and this beginning is typical of the twenty miles to the summit. High above the valley, on a maximum grade almost the whole distance, the road sweeps around two different forks of the Skagway river, adding six miles to its length but making it possible to reach the summit of 2,885 feet without switch back. It has however been questioned by able engineers whether this was the best location. The strata dip from east to west, and the other side of the valley would give a stable instead of unstable ledge. The west side is also the sunny and protected side, freer from ice and snow,

but on this side a switch back could not have been avoided. The road is narrow gauge, but the road bed and construction are adapted for broad gauge. It is one of the most solid and substantial road beds in America. The illustrations show the character of the work.

This railroad has already made Skagway the coming city of Alaska, and thus ended the race between the older Indian Dyea and the younger American city. It will do more. It will change the freight route to Dawson from an up-river to a down-river movement. Even this year barges to carry twenty tons can be bought at Bennett for \$300. or, competent men will contract to deliver freight with their own barges for four cents a pound to Dawson. Contracts are now being made from Seattle and Tacoma, from Victoria and Vancouver to Dawson via the White Pass for \$160 a ton, or eight cents a pound. This through rate may fall to six cents when the railroad reaches Bennett. Even eight cents is lower than the rates hitherto charged by the long mouth-of-the-Yukon route. Passenger travel will all take the shorter road and freight will inevitably follow passengers.

Another and more serious result of the completion of this railroad line to the summit is the inevitable diversion of a trade thus far almost exclusively in American hands to Canadian points and houses. Last year, the high duties imposed by the Canadians were fully off-set by the extortionate charges made for bonding and convoying Canadian goods through the American strip. This year the railroad furnishes the bond for a nominal charge and ships Canadian goods in bonded cars, delivering either at summit of pass, in British territory, or at Log Cabin or Bennett. It is not possible for American merchants to stand thirty per cent. duty and also the Canadian custom house delays, annoyances and extortions at Log Cabin. Last year Americans made these annoyances an off-set for a thirty per cent. duty, but hereafter the Canadians are protected by both duty and annoyances, and even if American meats and hardware are taken to the Yukon they will enter Canada elsewhere and go through in bond.

Happily however this possible loss of Klondike trade will be more than offset by the very sensational discoveries of gold made near the shores of Bering Sea, at Golovin Bay and Cape Nome. The climate at these points is comparatively mild, they are most easily accessible by boat for five months in the year and the region is described by those who know it as an Arctic paradise.

The Klondike madness is past. In two short years the savage trail with a dozen Indian packers has been replaced with transportation facilities with a capacity exceeding the requirements of the

Yukon basin for years to come. This excess will stimulate further developments. The country offers the widest field, for it is inexhaustibly rich.

Nowhere else as on this gold trail has the genius of engineers wrought such beneficent and rapid change in so short a time.

The evolution from hunter's path to railroad, through the intermediate steps of pilgrim path, mule trail, wagon road, was two thousand years in making in the Saint Gotthard Pass, the great high road between the most civilized portion of the ancient world and of the mediæval world, the road that led from the gloomy north to the rich south, rich in treasures, in food, in spiritual tradition and comfort.

Two short years as against two thousand have evolved the same succession of improvements on the highway over the White Pass back to a north, hideous in climate, without history, without sentiment, without food, but abounding in gold.

The author desires to acknowledge the permission given to him by Messrs. Winter & Pond, of Juneau Alaska; Mr. E. A. Hegg, of Skagway, Alaska; by the White Pass and Yukon Route Railway and by the Chilkoot Pass Railway, for the use of the copyrighted photographs from which the illustrations have been made. None of these illustrations may be reproduced without the permission of the owners of the copyrights.

THE UTILISATION OF THE WATER POWERS OF ITALY.

By Enrico Bignami.

WHILE on the one hand Italy is extremely rich in water powers which are capable of utilisation, on the other hand it is absolutely destitute of coal.

The Alps close it in from the northwest to the northeast, from the pass of Cadibona to Mount Majore, and slope to the sea level with steep and short gradients. The Appenines stretch from one end of the country to the other along its axis, from northwest to southeast. By these mountain chains the country is divided into three water sheds: the eastern, or that of the Adriatic Sea; the western, or that of the Tyrrhenian Sea; the southern, or that of the Ionian Sea.

The water-shed that drains into the Adriatic can be subdivided, according to mountain ranges and principal rivers, into the water-sheds of the upper Adriatic (which includes the great basin of the Po), the secondary basins between the Po and Marecchia, the Venetian basin, the coast of Trieste, and the peninsula of Istria. The rivers of this water-shed are:

(I.) The Po, with the following tributaries on the south: The Tanaro, Trebbia, Taro, Parma, Secchia, Panaro, Reno, etc.; and those on the north: the two Dore, the Stura di Lanzo, Sesto Agogna, Ticino, Adda Oglio, Mincio, etc.

(II.) The Adige.

(III.) The Brenta, Sile, Piave, Tagliamento, Isonzo.

A very few and unimportant torrents, namely, the Quieto, the Leme and the Arsa, empty into the upper Adriatic from the Istrian peninsula.

The other rivers of the Adriatic watershed are, from the north and south: the Foglia, Metauro, Esino, Potenza, Chienti, Tronto, Pescara, Sangro, Trigno, Biferno, Fortore, Candelaro, Cervaro, Carpella, Ofanto.

From the Tyrrhenian watershed, starting from the north, the torrents are: the Roja, Impero, Letimbro, Polcevera, Bisagno, Entella, and the rivers: the Serchio, Arno, Cecina, Cornia, Ombrone, Tevere, with their numerous tributaries, the Garigliano, Volturno, Sele, Liri.

The Ionian watershed is less important. It shows such little rivers as the Crati, Basento, Bradano, etc.

The longest rivers, and those draining the greatest area, run through the largest if not the most fertile stretches of agricultural lands, these also being the most industrious and enterprising regions of Italy. For example, Piedmont, Lombardy, Liguria, Emilia occupy the broad basin of the Po, and the greatest part of Venetia lies in the basin of the Adige. For centuries the principal wealth of these regions has been their industries, namely, silk, textiles, agriculture, cheese making, etc., but while the more recent industries are not lacking, yet they are pursued only in a very insignificant manner. Italy is thus under tribute to the rest of Europe for many articles which she might just as well produce at home if modern methods of production and power-supply were introduced.

As an example of the difficulties encountered we may take the case of calcium carbide. Although this valuable material was discovered as early as 1888, nothing was done to manufacture it in Italy until 1897. A few attempts were made in 1896, but nothing of consequence was done, and during that year 797 quintals (of 100 kilogrammes each) of Swiss carbide were imported into Italy. A furnace of fifty kw. capacity was started at Pont St. Martin, near Evrea, in 1897, but on account of disagreement among capitalists the enterprise closed down at the end of two months, and the right to take 2,000 h. p. from the stream, the Dora Baltea, was forfeited.

Other attempts have been made, however, among which we may mention the *Societa Italiana dei Forni Elettrici*, with a capital of 100,000 lire, operating under the patents of Engineer Lori, and starting its works at Narni in March of the same year. This was followed by the *Societa Italiana pel Carbuco di Calcio*, with a capital of 3,000,000 lire, and operating under the patents of the Aluminum Gesellschaft of Neuhausen, with a manufactory near the falls of Terni. About the middle of 1898 the *Societa Italiana dei Forni Elettrici* remodeled an old building near the gate of Foligno, and converted it into a carbide works, a power of 1,000 h. p. being transmitted seven kilometres from a waterfall 160 metres high on the Menotre. A power station was also constructed at the close of 1897 at St. Marcelle, near Aosta, where 700 h. p. were generated, and at Poggio Mirteto a small carbide works was constructed by Mongini, equipped with an improved electric furnace, built by Siemens & Halske, provided with movable bottom, tubular electrodes and a regenerating attachment for use with water gas. In addition to these the *Societa Anonyma Veneziana di Elettrochimica* was chartered in 1898, with a capital of 600,000 lire, but its factories are abroad,

the first being at Paternino, in Carinthia, where two Lori furnaces are being constructed.

These few examples show what may be done, and in fact there is no country in the world which, by reason of its mountainous slopes, its needs, its absolute lack of coal and its scarcity of other fuels, which can be expected to profit more than Italy by the development of electric power stations for the utilisation of the immense potential energy of its rivers and streams. If Italy had earlier attempted to substitute power derived from her own waterfalls for that imperfectly and expensively supplied by foreign coals, her present manufacturing and commercial inferiority would not be so humiliating. Possessing as she does valuable deposits of iron ore and copper, yet nearly all of this is exported, while the manufactured articles are imported, some of them from the very countries which purchase the raw material from Italy. If therefore electro-metallurgical processes could be substituted for the older methods the current required could be developed from the numerous water powers. At present the metallic imports of Italy come from America, Sweden and England, but with a home article in the market, produced by Italian water power and with cheap Italian labor, the double freight charges on exported raw material and re-imported products would form a natural protective tariff for the home product.

One of the principal difficulties in connection with the development of Italian industries lies in the fact that Italian capital has always shown itself reluctant to embark in industries of recent development, so that it has come about that German houses have taken the commercial lead, remodeling and expanding certain industries, and starting new ones. A most promising future might be realised for Italy if individual efforts could be backed by strong Italian financial concerns, who would map out a complete and comprehensive programme, using the water powers of Italy for agriculture, for industry and commerce, reclaiming marsh lands, improving existing industries and creating new ones, making more products for interchange, and ultimately increasing exports.

The question of drainage alone is one of utmost importance to Italy, and one which the development of water power could be used to solve. Out of the 259 districts into which Italy is subdivided only sixty-five are free from malaria, while nearly all could be relieved from this disability by proper drainage, and where necessary the drinking water could be sterilized by ozone, for all of which work the power is readily available, if capital were only forthcoming for its development.

Various laws, particularly that of August 10th, 1884, define the formalities which have to be complied with, and the conditions under which individuals or chartered companies are permitted to appropriate the power of public streams. The laws require that the applicant shall specify the business in which he intends to engage and the use he intends to make of the water, so that the government officials may consider the worthiness of the request, and, in case of doubt, refuse it. If the request has been granted and the applicant pays regularly the treasury dues or tax at the rate of 3 lire for each horse power granted, he becomes absolute owner of the right for thirty years; but he is under no obligation to develop his grant if he does not so wish. At the end of thirty years, if he has made use of it as promised, he acquires a perpetual right of renewal, in periods of thirty years each; otherwise he forfeits all rights. This provision is a wise one, as any water power not properly developed lapses again to the state.

Grants are allowed by the prefectures in which the power is situated, the exceptions being certain streams of special importance owing to their geographical position, such as those near the boundaries. The right to make grants on these is reserved by the general government.

In case of conflicting grants the present law recognizes only priority of application and grant. The same law provided that all the streams of the kingdom should be surveyed, but no appropriations were made for this important and costly work, and this feature has practically become a dead letter. The hydraulic officers of the Ministry of Agriculture and Commerce have only completed hydrographic surveys of the following rivers: the Tiber, the Arno, the Liri, the Garigliano, the Volturno and seven smaller ones.

The inconveniences and imperfections of this law, scarcely noticeable when the attempt to realise the water powers were of such a primitive character, became daily more apparent, as with the increase in the number of applications it was found that a priority right of a few horse power could check the utilisation of the greatest powers, thus causing serious harm to the country, which had been counting so hopefully on the increase of electrically-driven factories. Therefore, towards the end of 1894 a Ministerial Committee was appointed, whose business it was to propose needed amendments. This committee performed its work, but notwithstanding the excellence of the recommendations no legislative action was taken, and the old law remained unchanged.

In 1898 the matter came up again, for both the government and

the railroad companies had undertaken many investigations looking towards the use on a grand scale of electric traction on the railways.

The moment success had been obtained in the development of electric traction in other countries it was only logical that in a country poor in coal and rich in water power the idea should be broached of using the natural power of the country for its home needs. We do not propose here to discuss the question whether this is the best use that can be made of the water power, or whether it can altogether replace steam locomotives. Each particular case must be investigated in detail by competent experts; but it appears certain that in many cases these powers can be profitably used. The probability of the water powers acquiring value for this purpose has stimulated private applications for the very best of them, so that the government became alarmed, and under the seal of the Minister Afan de Rivera issued a circular conceived with the best of motives, but most unfortunate both in the regulations prescribed and in its consequences.

Among other provisions this circular ordered, that before a concession or grant were made it should be ascertained whether in any manner, direct or indirect, the water power in question might have any value for the railroads or for the state manufactories. If such were the case the application must be referred to the Central Administration. Most serious and illegal were these orders, for, thus by means of a simple ministerial circular, the spirit of a law passed by parliament, and still in force, was set at naught.

This Draconian act of the ministry interfered with too many private interests, and when its import became generally known protests were made on all hands. Some parties found themselves suddenly blocked in obtaining a grant long expected and applied for, applications were rejected that had cost them considerable sums of money and much expenditure of time, and on which they counted to extend establishments already in operation or to begin new ones, and their protests were more than just. Then there were also the mere grabbers, who added their protests to the others, claiming that their rights or expectations under the existing law had been infringed.

The circular of Afan de Rivera had to be withdrawn, but nevertheless the present law will soon be modified, and the commission appointed *ad hoc* has already formulated its proposals, which deserve to be reported at length, because the new law shortly to be approved with very few modifications will follow them without change. They are as follows:

- (1) Instead of mere geographical subdivisions of the water system.

that of relative importance has been substituted. Local authorities make the grants for all powers of less than 200 h. p., all others being reserved by the central government.

(2) The terms of any grant must be complied with before a predetermined time, or it will revert to the state.

(3) Grants already made can be merged into larger grants, provided those thus expropriated are indemnified by an equivalent quantity of water or of electric energy.

(4) In ascertained and imperative cases of necessity to the state it can reserve for its own use a water-power applied for by an individual, nor is it necessary for the state to have the same recourse to condemnation proceedings as would be necessary in the case of an individual.

A permanent Ministerial Commission is to be appointed to pass on all the applications which may affect the needs of the state.

(5) In case of rival claims priority has the right of preference if both cannot be granted, but that claim is to be favored which seems to promote the greatest public utility.

The provisions of the proposed law will certainly result in protecting both the state and real industries against mere grabbers. But in our opinion two amendments should be added if certain secondary but, on that account, not less valuable advantages are to be secured.

(a) The interests of the state are not narrowly those of the administration but in the largest sense those of the whole country. For example, the increase of some tax may benefit the treasury by adding to the revenues, but the increase does not on that account add to the real prosperity of the country. Thus also the impounding of water to furnish power to some military barracks, or even to drive a railroad, may, it is true, save the state some money, but this does not mean that the country as a whole is as much benefited by this public use of water powers as it would have been if private parties or companies had used it to establish a new industry.

(b) Oftentimes the survey and scientific study of the conditions affecting some water power require long and expensive preliminary outlay, and such investigations are similar to those required in exploring for metals and other minerals, and they should be afforded the same protection.

The distant transmission of electric energy is subject to the law of June 7th, 1894, of which the following are the most important provisions:

Article 1.—Every landowner must grant right of way through his

possessions for electric wires, either suspended or underground, to those who have secured the right, either temporary or permanent, to use electricity for industrial purposes. Exempt are the fronts of houses towards the public streets or squares, courts, gardens, fruit arbors and garden patches adjacent to the dwelling house.

Article 3.—Right of way must always be given to the transmission wires over canals or aqueducts or other erections, provided this right of way does not impede or diminish their usefulness to their owner.

Article 8.—The owner of electrical conduits is under obligation at all times to obey all laws and regulations made concerning materials, or that are, or may be passed to govern communications by means of the telegraph or telephone.

Rules:

Article 5.—The wires or conductors of an electric plant crossing public streets, railroads, rivers, torrents, canals, telegraphic or telephonic lines of public service, or erected near these, or that pass near or are attached to public monuments, cannot be erected without the previous consent of competent authority, unless the work has already received official approval as a work of public utility. All other conductors may be strung without official approval, but must be announced to such authorities at least ten days before work is begun.

Article 10.—In both the stringing of wires and the use of electric conduits the owner will be held responsible for public safety, and he will be required to use every precaution approved by science or practice, and especially to observe usual precautions.

Article 12.—It is particularly forbidden to string electric wires along streets or roads or the banks of streams, torrents, or canals already used or to be used for public telegraph or telephone service. Any exception must first be authorized by the Minister of Posts and Telegraphs, who will make it his business to determine the cases in which two different circuits can coexist without damage to each other, or what safeguards will be least burdensome.

The *Associazione Elettrotecnica Italiana* has appointed a commission and charged it to formulate laws suitable to the electric needs of Italy, recommending it to make use of all the information to be derived from similar German, Swiss and French societies.

In the mean time plants are multiplying, and already central stations are to be counted by hundreds and private plants by thousands. Most of these have been fitted up with foreign supplies, the house of Brown, Boveri & Co., of Baden, being at the head, as it has supplied many machines, mostly for alternating current, with nearly 30,000 h.p.

in the generators and about 12,000 h. p. in the motors. One of these machines is the generator of 1,500 h. p., furnished for the large plant in Paderno, where a water power of about 20,000 h. p. along the Adda is to be converted into electricity, to be used in Milan for public and private lighting and for traction.

This is the largest hydro-electric plant either already completed or about to be undertaken. Calculations were based on a fall of 28.81 meters carrying 45 cubic meters of water at its lowest stage, and a fall of 24.86 with 52 cubic meters at flood, yielding a total of 17,300 theoretical h. p. Six units of 2,160 h. p. each are to run regularly; the seventh is in reserve. The turbine in double, with axial discharge and centripetal entrance, and each wheel uses 7,809 liters a second when running at a speed of 180 revolutions. The fall is divided into 22.87 meters pressure and respectively 5.94 and 1.99 draft for low water stage and flood.

The current is three-phase alternating, the tension 13,500 volts, and a frequency of 42 cycles per second. The estimated loss is 9 per cent. in energy and 16 per cent. in tension; the distance is 34 kilometers in almost a straight line.

Next to the house of Brown, Boveri & Co. comes the firm of Ganz & Co., of Budapest, which generally furnishes both electric furnaces and turbine wheels of its own make, followed by the houses of Shuckert & Co., of Nuremberg; the establishment of Oerlikon, near Zurich; Siemens & Halske, of Berlin; Alioth & Co., of Bale; the Compagnie de l'Industrie Electrique, of Geneva.

The strongest Italian house is the Technomasio, of Milan, after which come Gadda & Co., and Brioschi and Finzi, who make a specialty of alternating generators and motors. There are other firms in Turin, Genoa, Savigliano, in all about ten, who cannot begin to suffice for the needs of the country, especially since the idea of utilising public waters for private plants of every kind has become so popular.

Recent official statistics give the total horse power of the steam boilers of Italy as 160,000 h. p., not including those for lighting plants, for traction of tramway lines and railways, nor marine boilers of any kind. Compared with the statistics of other countries Italy, to occupy a similar rank, should have at least 2,000,000 h. p. in order to compete industrially. In addition to the 300,000 h. p. already taken up, it has been calculated that about 5,000,000 h. p. remain, if proper use is made of the rapid falls of the Italian rivers, the Po alone being estimated to be capable of furnishing 1,000,000 h. p., at a cost for plant not exceeding 600 lire per h. p.

Data from a number of existing plants indicate that thus far the cost has averaged 300 lire per horse power, but even if they have cost double this amount they would pay well compared with steam. The operative cost of water power, including supervision and repairs may be put at 70 lire per h. p. per annum, operating 24 hours daily, while steam power costs at least 200 lire per h. p. per year of 300 days of 10 hours.

The advantage of water over steam is still more marked if it is taken in the mountains, near to the source of the hydraulic power and farther from coal. Here we may safely estimate the price of an electric horse power at 50 lire per year, while that of steam is at least 500 lire, an important feature when the use of electric power in metallurgical operations is considered.

YEAR.	INDUSTRIAL USE.	OTHER USES.	TOTAL.
1888	77	37	114
1889	85	31	116
1890	58	22	80
1891	55	24	79
1892	74	31	105
1893	67	30	97
1894	55	28	83
1895	26	56	82
1896	83	42	125
1897	87	37	124
Totals	667	338	1005

Grants of public waters from 1888 to 1897 in the various provinces:

PROVINCE.	MOTIVE POWER.	IRRIGATION.	TOTAL.	MODULES.
Piedmont	173	20	193	1986
Lombardy	93	15	108	2351
Venetia	77	34	111	617
Liguria	83	15	98	188
Emilia	35	14	54	275
Marches and Umbria	40	14	54	521
Tuscany	44	9	53	81
Latium	14	8	22	276
S. Adriatic	57	26	83	285
S. Mediterranean	18	16	34	198
Sicily	29	22	51	21
Sardinia	5		5	12
Totals	671	193	864	6711

As already stated, the law of August 10th, 1884, reserved to the central government the right to grant public water powers arising from lakes and from border rivers, leaving all others under the jurisdiction of the prefects of the different provinces in which they are situated.

In one of the official bulletins, the list on page 786 gives the grants in the ten-year period from 1888 to 1897.

The following table shows the extent of ground for which irrigation grants were made from public streams in the ten years between 1888 and 1897, and also the motive power developed under similar conditions during the same period:

PROVINCE.	HECTARES.	HORSE-POWER.
P edmont	777	33,021
Lombardy	1,170	49,795
Venetia		4,971
Liguria	7,166	2,318
Emilia	959	
Marches and Umbria	558	14,076
Tuscany	327	559
Latium	558	12,245
S. Adriatic	10,504	1,340
S. Mediterranean	4,221	3,590
Sicily	905	395
Sardinia		7
Totals	33,779	122,317

A study of the grants made in each year shows no real uniformity in the apportionment of public streams to agriculture and to industrial use. In the first six years of the ten-year period irrigation rights granted covered 31,142 hectares, and the horse power amounted to only 40,194. For the whole period the hectares were 33,779 and the horse power 122,317. This shows that in the first part of the decade there was a greater demand for irrigation plants, and during the last four years a greater development of power for industrial purposes.

Under these circumstances it is pertinent to ask: Why should not the State encourage industrial projects upon which a moderate tax of 3 lire per h. p. per year would return an annual amount of 20,000,000 lire? This figure may seem large, but it must be remembered that Italy now spends annually abroad not less than 100,000,000 lire for coal alone, not to mention the amounts expended for petroleum and minerals and metals which might be obtained at home.

The feeling is everywhere strong that the utilisation of water

power will soon be in full swing, and will bring with it the benefits coming from the development of home enterprises. That this will be accomplished with the aid of municipal undertakings is indicated by what has already occurred in Terni, Spoleto, Foligno, Narni, Spezia, Padua and elsewhere.

The law of December 27th, 1896, governs the chartering of electric car lines, but as yet the particular regulations have not been promulgated. This law does not even mention electric traction in Italy, but already there are electric lines in Rome, Turin, Genoa, Milan, Florence, Livorno, Naples, Varese and Bergamo, and they are being put in at Palermo, Catania, Messina, Spezia and elsewhere. Nearly all of these are equipped on the Thomson-Houston system, with overhead trolley.

But the new laws, which are now being prepared, will certainly provide for the regulation of electric traction, especially as experiments on a large scale in electric traction applied to standard railroads are being inaugurated by the two most important Italian railroad companies—that of the Mediterranean and of the Adriatic, in which the relative advantages of trolley, of third rail and of storage batteries are being compared. This last system is being tried and studied on a stretch of road with very frequent trains, between Milan and Monza, a distance of 13 kilometers. The experimental operation with third rail will be tried on a line 30 kilometers in length, while that with trolley will be on a third line 50 kilometers in length.

The *Associazione Elettrotecnica Italiana* has not yet decided which of the three systems is applicable to the solution of the traction problem on main-line railways, but has declared itself in favor of facilitating and accelerating the trials with the different systems, and has also recommended that the authorities should permit the use of high pressures on the main wires of primary lines, especially contact systems, proper and minute regulations being adopted to guarantee the public from danger and injury.

If electricity generated from water power is to be used for railway purposes it will necessarily involve transmissions over relatively great distances. If the equivalents of 500 to 1,000 h. p. are to be transmitted over distances of 50 to 100 kilometers pressures of 2,000 to 3,000 volts at least must be used. There is, however, no reason why such pressures should not be safely used, and both Kapp and Thompson maintain that there is no good reason why the common limit of 500 volts pressure should be considered, it being altogether probable that the usual limit of 500 to 600 volts will be abandoned in favor of

higher voltages for use on electric railways. Weber, of Zurich, very properly calls attention to the fact that the dangers from high pressures in electric railways are small compared to the other dangers inherent in any railway service. The possibility of disastrous accident when running trains at speeds of 60 to 70 kilometers an hour on dark and stormy nights is far greater than that involved in any form of electric driving.

The true solution of this portion of the problem appears to lie in the adoption of polyphase currents of high pressure directly in the motors. It is true that the polyphase current is deficient in that flexibility of speed regulation which is demanded in city tramway lines, but it appears to be well adapted for the special conditions and more limited requirements of main-line railway service. In this case various methods of regulation may be adopted, either by the insertion of artificial resistance in the induction or inductor circuits, or else there may be a double equipment of motors, one of which will be operated continuously at high pressure, and the other with an induction of lower pressure, which will be called into play on those stretches only where the speed is to be reduced. With such a double equipment of motors it will be possible to meet the requirement of greater tractive power when it is necessary to reduce the speed of the train.

It is an economic truism that the proper method for Italy to pursue is to develop those industries for which she has all the facilities within her own borders. These have been shown to be included in the departments of metallurgy, industrial technology and transportation. The mineral wealth of the country can be developed, transformed, utilized or delivered for export, all by the utilisation of the natural sources of power within her borders, to the great benefit of the whole population as well as to the increase of the wealth of the state.

ENGLISH AND AMERICAN LOCOMOTIVE BUILDING.—II.

By Charles Rous-Marten.

BEFORE entering upon the second phase of my subject I should like to point out once more that my remarks are intended to have simply a *general* application. I do not assert or imply that there are no deviations from the practices which I am about to mention as prevalent respectively in Great Britain and in the United States of America. I merely desire to make it plain that such deviations are exceptions to an otherwise prevalent rule. For instance, the single driver system may be said to belong emphatically to British practice and not to American. Yet America has built two single-wheelers at any rate which have won considerable fame in their day, viz., the Eames engine, which was sent over to England some years ago in connection with brake-trials, and the more recent "No. 385," which, I believe, is still working with success. Nevertheless I might reasonably instance the case of single-wheelers in Great Britain as one prominent divergence in respect of practice, on the ground that this is not an American custom. In short my observations must be taken as dealing with the *rule*, not as denying the existence of occasional exceptions.

Another preliminary remark which I desire to make is that I cannot pretend, within my present limits of space, to enter into the more minute details of construction. These would require a whole volume, not a mere article. Therefore I must confine myself to salient features and general terms.

It would appear reasonable to begin my analysis with the virtual foundation of the locomotive—its frame. Here at once we are confronted with an entire difference between the methods of the two countries. In England plate framing is practically universal. In America bar framing is equally the prevalent rule. Yet, curiously enough, the latter system did not originate westward of the Atlantic. It was largely adopted by Mr. Bury in the early days of railways in England, and may be said to have gone out with him and his peculiar style of locomotive. Mr. Bury was a somewhat strong-willed, and in the opinion of some of his contemporaries wrong-headed, man. He unquestionably impeded and prejudiced the London & North Western Railway in its early days by his obstinate adherence to his small

four-wheeled type of locomotive, when the growing traffic already had imperatively called for the larger six-wheeled engines that were used on other lines. In the end the stern logic of hard fact was too strong for Mr. Bury, and he had to go. His toy locomotives with their curious round fire-boxes and high copper domes, like small haystacks, over the fire-boxes, were speedily relegated to inferior duty and were replaced by more powerful machines. With Mr. Bury and his "haystacks" went also bar-framing, so far as England was concerned.

It is no part of my function to pronounce judgment here upon the relative merits of the two methods. Each seems to possess its own advantages, but the difficulty of appraising their respective value is greatly enhanced by the extraordinarily diverse theories put forth by their respective advocates. Within my own knowledge a sharp controversy took place on the subject several years back between eminent engineers on opposite sides of the Atlantic, in relation to the question of the preferable build of locomotives for employment on rough colonial lines.

An order had been given for some American engines, it being held that these would be most suitable to colonial roads hastily and cheaply constructed, with light permanent way, steep gradients and frequent sharp curves. A British engineer took exception to this view and contended that the superior strength and rigidity of their plate-framing rendered British engines far safer and more economical on a rough and light road which necessarily made the utmost demand upon stability and endurance. He condemned the American bar-framed locomotives as "loose jointed affairs resembling so many wicker baskets." He was promptly answered by an American engineer who twitted him with utter ignorance of the primary conditions involved. "It is quite true," he said, "that our American engines may be compared to flexible wicker baskets—but *therein lies their merit*. They are so flexible that they glide easily over rough roads and round sharp curves on which a stiff, unyielding British engine would soon knock itself to pieces. It is the remarkable flexibility of an American engine that renders it so supremely suitable to new countries with their light-built and curved lines."

Now the matter might conveniently have been left here as illustrating a vital divergence of engineering opinion and a rudimentary but important point—that is to say, whether rigid or flexible locomotives were better suited to light, rough, curved roads. A new and fearful complication was introduced however by a second American

engineer, who "went for" both the previous writers "with the gloves off." The bare suggestion that the American engine was a "loose-jointed affair," nay, even that it was more flexible than the British machine, filled him with derision. Every child knew, he practically declared, that the bar-frame of an American locomotive, instead of being more flexible than the plated frame, was infinitely stronger, stiffer and more rigid. Therein, he maintained, lay its merit. You did not want an engine to go bending and twisting itself all over the place, however rough the road might be. Indeed the rougher the road the less the engine ought to bend and wriggle. What you wanted was in effect an engine that was so strong and stiff that it could ride roughshod over all curves and inequalities and weak rails and slight permanent way. The grand advantage possessed by the bar-framed locomotive was its remarkable firmness, strength and rigidity. Nor would he admit that these advantages applied only to light and rough roads. Clearly, he urged, the engine that did so well on bad roads must do even better on good tracks. Therefore, he concluded, the bar-framed engine was the best for all roads and purposes.

It is needless to pursue the controversy, in which no two of the disputants could agree even as to the premises. Nor is it necessary to mention that not one of the disputants was in the smallest degree shaken in his own opinion by the demolition which in the opinion of the other two participators in this "triangular duel" was so complete and crushing. The ultimate outcome of the somewhat comic wrangle was to leave the whole question an open one.

Personally, as I have said already, I am indisposed to record my vote on either side. I have had many opportunities of observing both systems in operation and I candidly confess that one seems to me to give in practice as good results as does the other. And the fact remains that American engines as a rule have bar-framing—British engines plate-frames.

Another very prominent difference between British and American locomotive practice is that American designers prefer to place as many as possible of the working parts *outside*; whereas the British plan is to put everything *inside*. Here again we have diametrically opposite methods, and here again there is much to be said on both sides. On behalf of the American method it may fairly be urged that much is gained in respect of the easy accessibleness of the working parts for examination and manipulation when required. Against this system it may be contended with equal fairness that the outside position involves greater exposure to variation of temperature—especially to



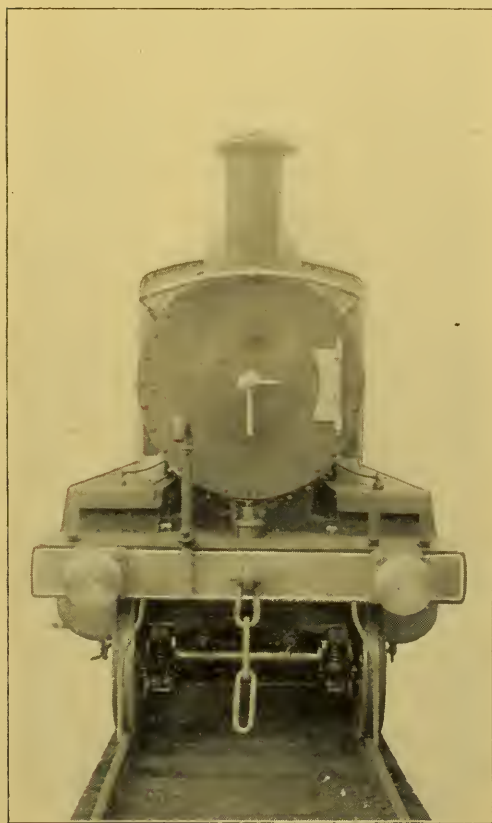
ENGLISH GOODS ENGINE, MIDLAND RAILWAY.

cold air in winter, and to dust, etc., while the lateral dimensions of the engine are augmented to an extent often inconvenient and undesirable when, as in England, the limitations of space are so materially restricted as compared with those available on the American and European Continents.

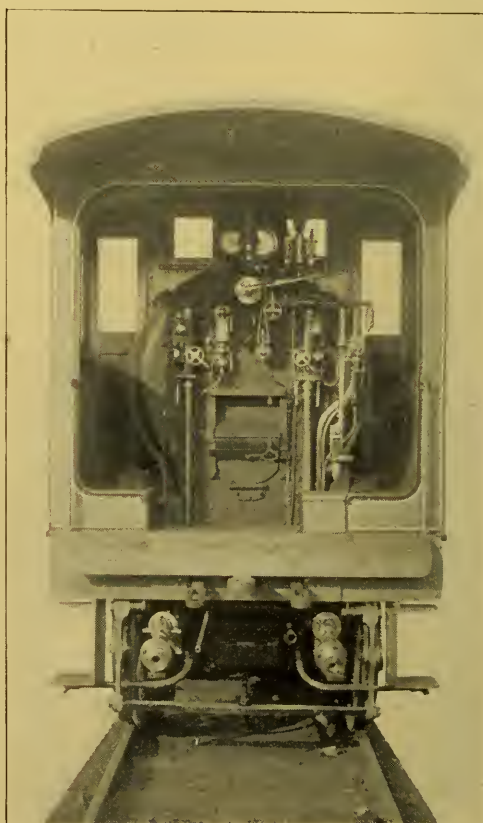
The extent to which this drawback operates in British locomotive designing is seldom adequately appreciated. Yet the difference is so large that whereas in the United States the loading gauge permits a height of fully 15 feet, and an extreme breadth of 10 feet 3 inches, in Great Britain the height cannot exceed $13\frac{1}{2}$ feet, and the extreme breadth 9 feet. The penalty for excess in height would be that the peccant locomotive would have its chimney knocked off by the first bridge or tunnel that it entered, while excessive width would involve disastrous collision with the platform of the first station entered. The loading gauge on the European Continent may be taken roughly as intermediate between those of Great Britain and the United States of America.

AMERICAN GOODS ENGINE FOR MIDLAND RAILWAY. BUILT BY SCHENECTADY
LOCOMOTIVE WORKS.

It will therefore be readily realised that American and even European dimensions are not feasible in British locomotives, and that structural disabilities thus exist in the latter case which no ingenuity of designers can overcome. Apart from this insuperable obstacle, however, it may be admitted that British opinion prefers the inside method as inducing superior neatness and symmetry of external appearance. There is unquestionably an attraction to the temperament of the British engineer in the concealment of his *modus operandi*. His

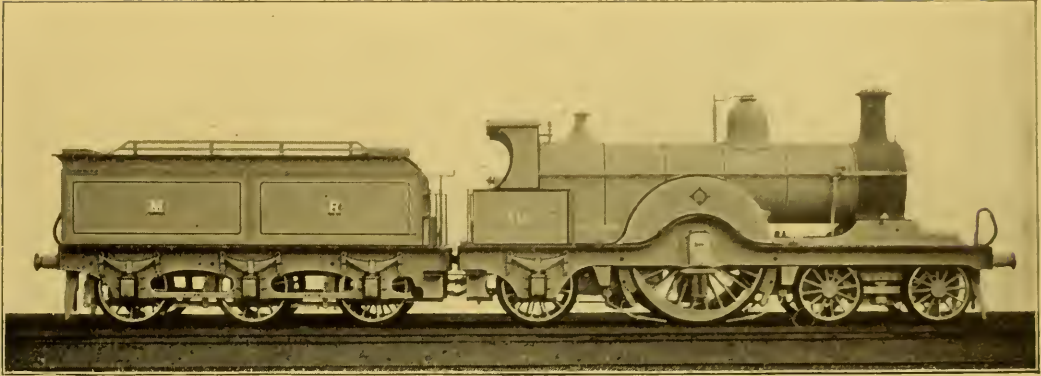


FRONT VIEW OF SCHENECTADY ENGINE FOR MIDLAND RAILWAY.



REAR VIEW OF SCHENECTADY ENGINE FOR MIDLAND RAILWAY.

engine runs along as if of its own volition. No sign of its motive power is permitted to appear externally. All outside is symmetrical neatness. The *end* is visible enough; the *means* are studiously kept out of sight. There is a certain charm as of unseen potency about this arrangement and the æsthetic superiority seems unquestionable. Nevertheless the free accessibility of the working parts and their constant visibility must be admitted to possess elements of safety as well as of convenience. It will barely be pretended that working gear can be so easily and efficiently examined from underneath the engine in



ENGLISH EXPRESS LOCOMOTIVE, MIDLAND RAILWAY.

darkness illumined only by a hand lamp, as outside in full daylight or under the glare of the brilliant lights of a station. The point is, as usual in engineering problems, whether this advantage is or is not too dearly purchased at the cost of drawbacks in other respects.

Here, again, bearing in mind the wide difference of opinion that exists on this point among the highest authorities I do not feel warranted in recording a verdict. Instead of pronouncing judgment on a point as to which the most competent judges differ *toto coelo* I prefer to deal a little more fully with one detail upon which virtually the whole matter turns.

Practically the issue resolves itself into that of inside *versus* outside cylinders. For if the cylinders be outside then most of the working gear will have to be outside also, and *vice versa*. Here it is a case of "Athanasius against the world," and Great Britain is the Athanasius.



EXPRESS LOCOMOTIVE, ATLANTIC CITY RAILROAD.

This engine, built by the Baldwin Locomotive Works on the Vaucrain compound system, hauls the fastest train in the world, regularly making the run from Camden to Atlantic City, 55½ miles, in 50 minutes.



OFFICES AND TOP YARD, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.



BOTTOM YARD, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

While the rest of the world votes almost "solid" for outside cylinders, England is practically unanimous in adopting the inside position. In fact the *sole* exceptions to this rule on any leading railway in the whole United Kingdom—as regards modern engines—are confined to cases of exceptional design which render outside cylinders absolutely imperative. The only cases of outside cylinders being used in engines of modern design on any British main line are the following: (1) Mr. Patrick Stirling's 8 feet single-wheelers on the Great Northern—outside cylinder necessitated by height of driving axle. (2) Mr. F. W.



LOCOMOTIVE YARD FROM STATION ROOF, MIDLAND RAILWAY, DERBY.

Webb's three-cylinder and four-cylinder compounds on London & North Western—high-pressure cylinders necessarily outside owing to space between frames being occupied by low-pressure cylinders. (3) Mr. H. A. Ivatt's ten-wheeler, No. 990—cylinders placed outside to get both pairs of coupled driving wheels in front of fire-box with view of obtaining augmented length of fire-box with pair of carrying-wheels 1619, for virtually same reason as in case of Mr. Webb's compounds, behind. (4) Mr. Wilson Worsdell's three-cylinder compound, No. and (5) Mr. Wilson Worsdell's new six-coupled express engine be-



ERECTING SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.



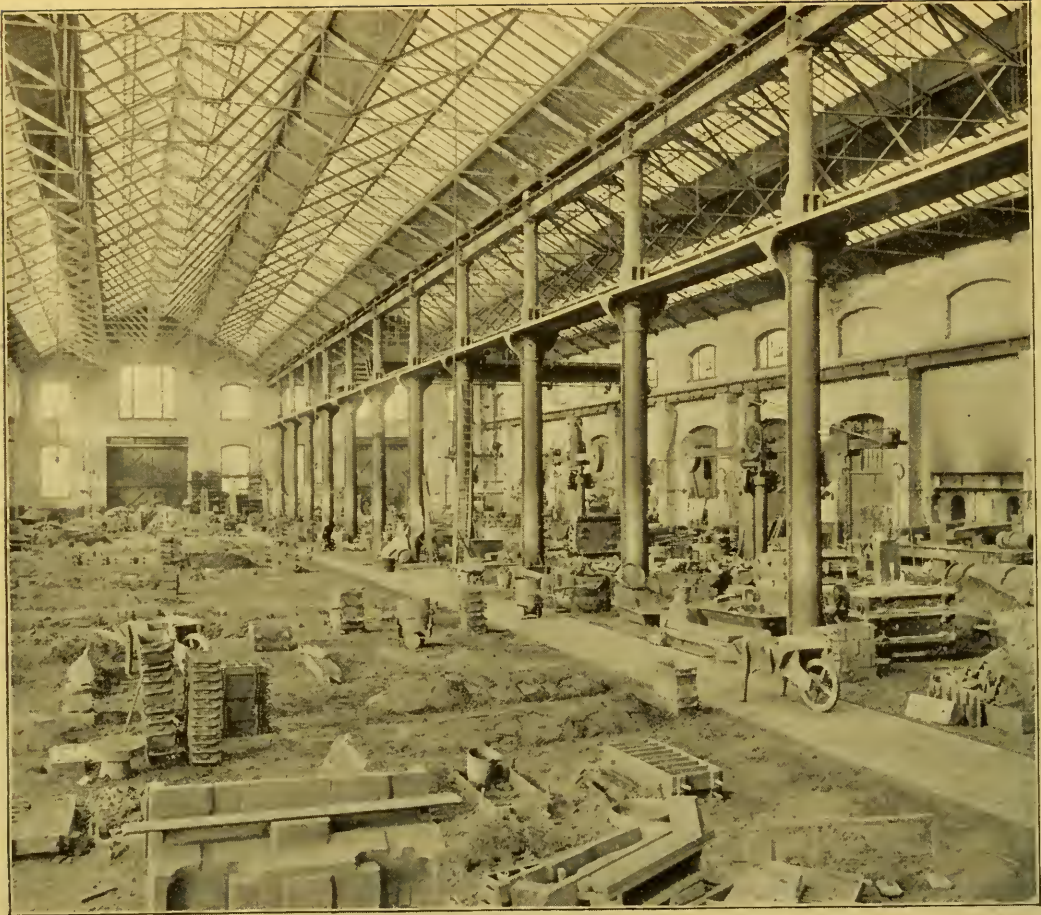
ERECTING SHOP, SCHENECTADY LOCOMOTIVE WORKS.



BOILER MOUNTING SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.



BOILER ERECTING SHOP, SCHENECTADY LOCOMOTIVE WORKS.



IRON FOUNDRY, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.



IRON FOUNDRY, SCHENECTADY LOCOMOTIVE WORKS.

cause of difficulty in placing cylinders inside and having the connecting rod clear the axle of the first pair of coupled wheels.

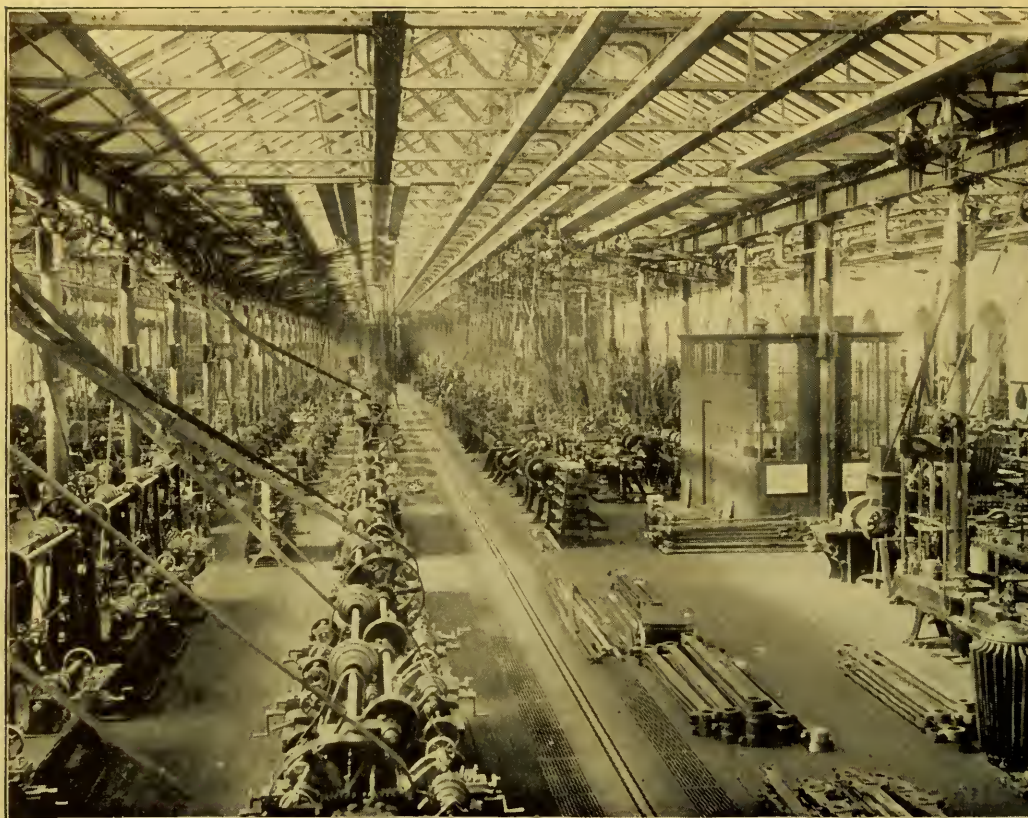
Few points in locomotive construction have been the subject of stronger dispute than this one of the position of cylinders. The advocates of the outside position claim that by placing the cylinders outside the frame, not only are they far more easily accessible, but also a straight driving axle can be used and the crank axle with its essential



MACHINE SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

weakness of form, can be dispensed with. It is pointed out that if a double-crank axle be set up on end and regarded as a column it manifests about the weakest shape that could be devised, and one which possesses the minimum of strain resisting capacity, especially as compared with a straight axle consisting of one homogeneous bar of steel.

All this is practically indisputable. But the reply, as usual in such engineering cases, is that the unquestionable advantages may be too dearly bought. Putting aside, as a merely æsthetic matter, the supe-



MACHINE SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.



MACHINE SHOP, ROD WORK, SCHENECTADY LOCOMOTIVE WORKS.



BLACKSMITH SHOP, FRAME WORK, SCHENECTADY LOCOMOTIVE WORKS.



BLACKSMITH SHOP, SCHENECTADY LOCOMOTIVE WORKS.



PAINT SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

rior compactness and neatness in appearance of an inside cylinder engine, it is contended that the outside position for cylinders has several structural disadvantages. In the first place the cylinders are so far apart that the pull of the pistons and piston-rods is at the farthest possible point from the middle line of the engine. In these circumstances the alternate reciprocating motion of the pistons and rods must needs set up in a greater or less degree a "punching" or "boxing" action which is obviously prejudicial to the steadiness of a locomotive and consequently tends to increase the wear and tear. That this detrimental action may be, and has been, reduced to a large extent through modern improvements in construction is undeniable. Nevertheless the "punching" action must always remain even if in a small degree, where outside cylinders are employed. Its influence may be slight but it is there *quantum valeat*. In this respect the superiority of the inside cylinder with its direct middle pull is manifest.

Secondly it is argued that the outside position exposes the cylinders unduly to vicissitudes of temperature and especially to cold. The pas-

sage of the engine even through a still atmosphere at a speed of 60 miles an hour or more involves virtually the rushing of a cold gale or even hurricane over the whole of the exposed external surface of the cylinders. Clearly this must cause some loss by condensation. Indeed the fact is implicitly admitted. Steam-jacketing has been suggested and tried as a corrective of this drawback to outside cylinders, but the results obtained so far have been somewhat discrepant, one engineer claiming to have gained an advantage equivalent to an additional half-inch in his cylinder's diameter, while another finds no benefit at all to accrue from steam jacketing. In either case the fact remains that outside cylinders do possess this disadvantage of exposure and excess of condensation.

A third consideration which has operated in securing the use of inside cylinders in Great Britain wherever feasible is that the alternative course necessitates a stronger and heavier and therefore more costly mode of construction. A moment's thought will show that it is much easier to fix two cylinders stably as a single block of metal between the two frames, than to attach each cylinder separately to the outside of one frame and yet to give it as much stability as if placed



CYLINDER SHOP SCHENECTADY LOCOMOTIVE WORKS.

inside. This can only be achieved by means of a somewhat more expensive mode of construction.

But the advocates of inside cylinders do not stop here. Some of them boldly deny the existence of any greater weakness in the cranked axle than in the straight one, and even assert that the latter possesses a peculiar weakness of its own.

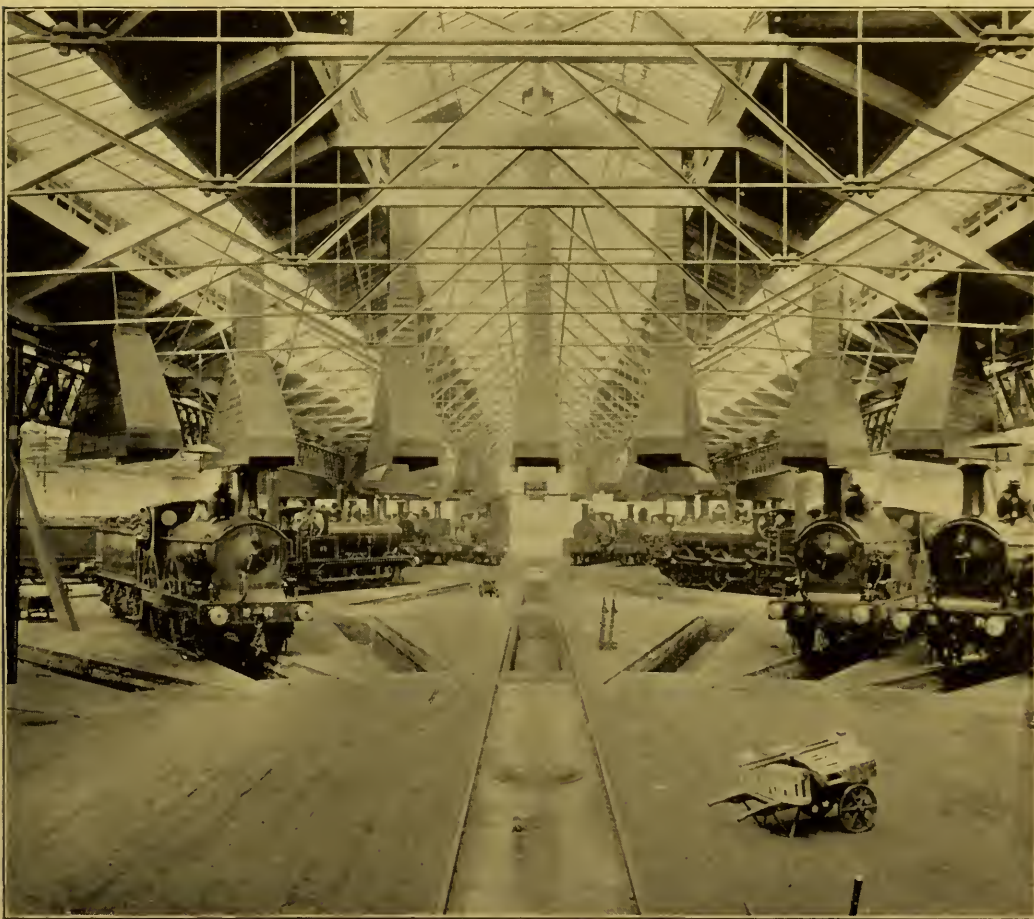
The late Mr. William Stroudley, a former locomotive Superinten-



WHEEL SHOP, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

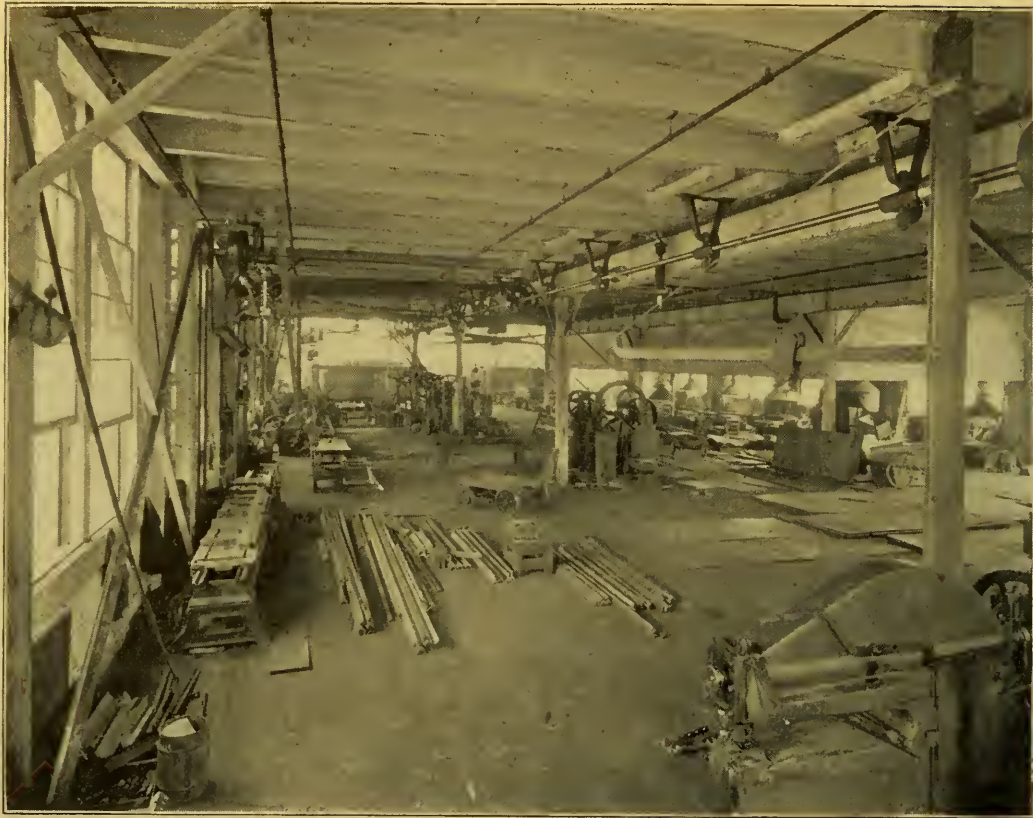
dent of the London, Brighton & South Coast Railway, expressed during a conversation with me on this point, very strong views to the effect just now indicated. "A crank axle does not break *because* it is cranked," he said, "if it be properly designed and constructed of good material and in due proportion. Its shape has no inherent weakness for the purpose it is intended to fulfill, if these essential conditions are duly observed. Fractured crank axles are usually found on examination to have had some flaw either in design or material, or construction. I have not (he continued) found them break more

frequently than straight axles if even so often. You must remember that the straight axle is turned by a power applied to its extreme ends and that it does not move until the utmost strain in the direction of torsion has been applied to it. That torsion must have a tendency to loosen the fibres of the metal, and so to weaken the axle, while if any hidden flaw should exist this same action would be most apt to find it out and led to fracture." The late Mr. Patrick Stirling, locomotive superintendent of the Great Northern Railway, was another



NEW SHED, LOCOMOTIVE DEPARTMENT, MIDLAND RAILWAY, DERBY.

thorough-going advocate of inside cylinders, although he designed and built some of the most famous outside cylinder engines known in railway history, the 8 feet single-wheelers. "But I only used outside cylinders," he said to me, "because I could not have inside ones with such a large wheel (8 ft.) and so long a piston stroke (28 in.). It was essential to my design to employ these dimensions and so I had to use outside cylinders and a leading bogie also, neither of which I should have adopted could I have avoided doing so." Even Mr. William



TANK SHOP, SCHENECTADY LOCOMOTIVE WORKS.

Adams, long the most eminent "outside cylinderist" in England, ultimately abandoned the plan in every class of engines excepting those for the fastest express work. In the latest years of his rule on the London & South Western Line he designed and constructed four different classes of inside cylinder locomotives, two tender and two tank, one reason being, I believe, their superiority in point of cheapness.

But in the case of his 7 feet and 6 feet 6 inch coupled express engines, Mr. Adams, to the last, used outside cylinders—a course which has been reversed by his successor—and in various conversations with myself he justified their use on the ground that notwithstanding the disadvantages already pointed out, which he frankly admitted to exist, the advantages of easy accessibleness and of a straight axle were sufficiently great to compensate for all drawbacks. This too is the view held by nearly all American engineers and by most European continental ones also. It will therefore be recognised that here, as in the case of the bar and plate framing, we have a distinct and radical difference between British and American methods in construction. And here again I may remark that it does not fall within my province to adjudicate between the two systems.

Pursuing my analytical examination I come next to a group of differences which may all be classed under the head of economy in prime cost as against superior durability. In the United States the fire-boxes and boiler-tubes of locomotives are usually constructed of steel. In Great Britain the fire-boxes are almost invariably made of copper and the tubes of brass or copper. Obviously, steel being a far cheaper material, steel tubes and fire-boxes will cost much less than brass or copper tubes and copper boxes. But the latter are far more durable and so in accordance with that British preference, on which I enlarged in my previous article, for everything that is lasting and durable, the more costly material is employed as a matter of course.

In America on the other hand, similarly carrying out the principle mentioned in the same article, steel tubes and fire-boxes are used because, while they cost less, they are found to be quite good enough for the purposes they are intended to serve. The American engine while it lasts is quite as good a machine and quite as efficient per unit of nominal power as the British locomotive, only it will not last so long. And the American engineer says with much emphasis and reason that he does not want it to last so long because it must in a decade or little more become virtually obsolete and block the way of more modern and up-to-date machines with which he would like to replace them. And so he contents himself with his cheaper steel tubes and fire-boxes and gets as much work out of them as his British *confrère* does out of his more expensive brass or copper. By the time the steel tubes and boxes are worn out he is almost ready for a new engine. It is no doubt true that brass or copper tubes and copper boxes are more economical in respect of repairs. But as in the case of cylinder-position the engineer, British or American, holds that his own method, if it has some disadvantages, is on the whole a better one.

Much the same may be said of the cast-iron wheels with chilled rims, so largely employed in American practice. The position of the sand-box—over the boiler in America, in front of the driving wheel in England—is a detail of hardly sufficient importance to discuss at length. The superiority of the American cab in respect of the comfort and convenience it affords to those engaged in working the engine and the greater facility with which it therefore enables them to perform their important duties seem to me indisputable. But some British railways are following the example of the United States in improving their cabs, notable instances being afforded by Mr. Wilson Worsdell's clerestoried cabs, on his new North Eastern engine and by Mr. J. T. Macintosh's roomy and commodious cabs on his Caledonian "Dunala-

stairs" and "Breadalbanes." So here again no actual international difference can any longer be predicated.

The use of the four-wheeled leading bogie is now universal in the case of new British engines, and I may observe in passing that, like bar-framing, so often believed to be an American invention, the bogie too had its origin in the Mother Country. The bogie tender is, I believe, a strictly American idea, but it has found its way to Great Britain and I suspect that it has "come to stay." It is established at any rate on the Caledonian, Glasgow-South-Western and London-South-Western lines, and is coming on the Midland also. In respect of valve gear, single or double slide bars, plain or fluted side rods and many other details, each country has a large diversity of practice, and none of these can be cited as peculiar to either country.

But while Great Britain and America both freely use the fluted coupling rods, which I believe Mr. T. W. Wordsell, when locomotive superintendent of the Great Eastern Line, was the first to introduce, in 1884, America, so far as I am aware, stands alone in fluting also the connecting rods, although the augmentation of strength proportionally to weight manifestly accrues in one case almost as much as in the other.

Hitherto the wagon-top design of boiler has been, I fancy, peculiar to America, while the flush-top boiler has been a British specialty. But the Belpaire fire-box is gaining ground rapidly in Great Britain on account of its superior capacity for steam generation, and I understand that it is gaining considerable acceptance also in the United States. At all events the Belpaire system does not constitute a point of marked difference between British and American practice, and the prevalence of the flush boiler on our side of the Atlantic and of the wagon top on the other shows a distinct tendency to diminish in each case in favor of the Belpaire plan.

There was a time when the chimney offered an infallible indication of British or American parentage. But "we have changed all that." The huge inverted cone and the double cone (or "diamond") surmounting a cylindrical column which used to be the typical American "smokestack" as contrasted with the plain cylindrical flue, often flanged at the top, which still remains the regular British "funnel"—though utterly unfunnel like in shape—have been succeeded by a chimney which differs little if at all in general design from that seen in Great Britain. The extended smoke box which in America replaced the single inverted or double cone as a spark catcher, has traveled now to Great Britain as well, and may be found on the Great Western,

North Eastern and Glasgow-South-Western lines. It is no longer an Americanism.

In short the distinctive features of the British and American systems are now but few. Their tendency is to become fewer still. It is true that such at present exclusively American designs as the "Consolidation" (8 wheels coupled and 2 wheeled bogie) "Decapod" (10 wheels coupled) "Twelve-wheeler" (8 wheels coupled and 4 wheeled bogie) "Columbia" (four wheels coupled with leading and trailing 2 wheeled bogies on the Vaucrain compounds) have not yet found their way to England, nor the inside-cylinder single-wheeler or the Webb compound to the United States, while the only "Mogul" engines (6 wheels coupled and 2 wheeled bogie) built in England by Mr. W. Adams for the Great Eastern Railway have been condemned and broken up; but there is I think a growing tendency toward assimilation between the systems of the two English speaking nations, so far as this is feasible in view of the difference in the conditions to be satisfied. England has not the long journeys of America or the American loading gauge space which would permit of large vertical or lateral extension of existing maximum dimensions. But I certainly anticipate that the present importation of the Midland, Great Central and Great Northern line of American Mogul goods engines will have an appreciable influence upon the future of British locomotive engineering.

In a third article I hope to be able to give some information as to the immediate results of the experiment. I shall at the same time touch upon a few other points of difference between American and British locomotive practice, which limitations of time and space compel me now to postpone. I append to the present article some illustrations of Midland locomotives and of the famous Derby works of the same English line, reproduced from some very fine photographs for which I am indebted to the courtesy of Mr. S. W. Johnson, the able locomotive superintendent of that important line. Acknowledgments are also due to the Schenectady Locomotive Works, of Schenectady, New York, U. S. A., and the Baldwin Locomotive Works, of Philadelphia, U. S. A., for the use of photographs of engines and works.

THE WITWATERSRAND MINES AND THE BOER GOVERNMENT.

By Frederick H. Hatch.

THE political phases of the South African situation have been so pushed into prominence recently, and the party feelings, seemingly inseparable from political differences, have run so high, that there is danger of losing sight of the fact that the fundamental question is not one of politics at all, but of engineering industry and economics.

It is of the freedom—perhaps of the existence—of mining enterprises whose prosperity touches closely the professional, the manufacturing, and the financial world. In this article an attempt is made to show what are the heaviest burdens now pressing on the mining industry of the Rand, and preventing the attainment of the full measure of success presaged by the unequalled natural conditions and justified by the careful study and advanced practice of the owners and managers.

The Witwatersrand mines produced last year gold bullion having the value of fifteen million pounds sterling, being 28 per cent. of the world's total output. This result was obtained from the operation of seventy-seven companies, having an average aggregate milling power of 4,765 stamps. The properties of the majority of these companies are situated on the outcrop of the gold-bearing conglomerate beds, only eleven so-called "deep-level" companies having been at work during the year. As the other deep-level properties, now being developed on the second and third rows of mines, come into operation, the output will be very largely increased. It is estimated by good authorities that, during the next five years, the number of stamps dropping will be increased to more than 12,000.* Since the average duty of a stamp in the Witwatersrand mills is 1,500 tons per annum, 12,000 stamps would crush 18,000,000 tons of ore yearly. On the assumption that the ore will maintain its present grade, namely between nine and ten dwts. of fine gold or, say, forty shillings to the ton—the output from the Witwatersrand fields would, on this basis, amount to thirty-six million pounds sterling per annum.

It is the great results already obtained and the still greater prob-

* See the Annual Report of the Rand Mines Co. Lim., for 1898, p. 38.

abilities of the future that have focused the attention of the mining and financial world on the Transvaal, and have drawn to the Rand, from all parts, that immense population of busy workers who make up the body of the "Uitlanders," or foreigners, and form such a marked contrast to the older but less progressive Boer population. In consequence of the marvellous success of the goldfields the pace has become too rapid to please the Boers, who find themselves in danger of being swamped in the crowd of foreigners. Already, according to official returns, the Uitlanders outnumber the Boers in the proportion of at least three to one.* Hence the efforts of the Boer autocracy to maintain their present supremacy.

But the Transvaal owes its flourishing economic position solely to the industry of the Uitlanders, its industrial development dating from the discovery of the gold-bearing conglomerates of the Witwatersrand in 1885. The revenue of the South African Republic for that year was £117,876. By 1897 it had increased to £4,480,217 and last year it was £3,983,560. This revenue is derived, either directly or indirectly, almost entirely from the activity of the Uitlander population and the greater part of it has its source in the Witwatersrand mines.

On first thought one would have imagined that, in a country whose prosperity is so entirely dependent on the success of a growing industry, it would have been the prime care of the Government to foster and assist, in every way possible, that industry in its development. But the Boers take another view. The progress of the fields is hampered and impeded by heavy taxation and monopolies, and, what is perhaps still worse, the huge revenues are squandered in the erection of military forts, in the purchase of arms and ammunition, and in other similarly useless expenditure, instead of being laid out on railways, roads, irrigation, and other works calculated to develop and improve the country. The Uitlanders, being debarred from political rights, have no voice in the direction of affairs, and see with increasing disgust and impatience this waste of the resources of the country.

In the early part of 1897 a commission was appointed by the Transvaal Government to enquire into the grievances of the Witwatersrand miners. The evidence given before that commission showed that the cost of working the mines was unwarrantably high, in view of the existing favourable conditions and of the highly organised methods employed. Further, that this high cost was due to the ex-

* The *Staats Almanak*, an official publication, gives the male Boer population as 29,279, and the male Uitlander population as 137,121.

tortionate carrying rates of the railways, to the exactions of the dynamite monopolists, and to the inefficiency of the native labour.

The cost of working, averaged for all the mines, was in 1897 about 29 shillings and 6 pence per ton milled. Since then some slight reductions have been made, principally in native labour, bringing the average for 1898 down to 28 shillings. This cost is arrived at by deducting the dividends paid from the value of the total production, a severe but serviceable method of calculation.

It was shown to the commission that the different items of expenditure represented at that time the following percentages of the total:

White labour	30	per cent.
Native labour	23	"
Explosives	10	"
Coal	8	"
Stores	19	"
General charges	5	"
Total	100	"

We will take each of these items *seriatim* and endeavour to show what economies have been effected since the time of the commission.

Under the item white labour are included all white employees from the manager downwards. The number of white men now employed on the mines is nearly 10,000, as against 8,000 in 1897, and the average rate of wage is at present £26 per month, as against £24. In view of the high cost of living on the Rand, there is little hope of any reduction being made in this direction; indeed, the average wage now paid is, as shown above, even higher than it was in 1897.*

Natives (*i. e.*, Kaffirs from various parts of South Africa) are employed on the mines for all kinds of manual work, such as drilling, shoveling, filling, tramping, firing, etc. They outnumber the whites in the proportion of nine or ten to one, there being at present from 90,000 to 100,000 black employees. The average rate of wage per head is at present about £2 10s 0d per month, to which may be added another 10 shillings for food; for besides their pay, the natives employed are housed and fed at the expense of the companies. In 1897 the average cost per "boy" was about £4 per month, so that already a considerable saving has been made under this head.† The quality

* A recent report of the Rand Mines Co. shows that the cost of white labour for 1898 was 34.5 per cent. of the total expenditures on these mines, as against 32 per cent. during 1897.

† The cost of black labour in the Rand Mines Co. during 1898 was only 15 per cent. of the total expenditure.

of the labour, however, has not improved and leaves much to be desired. A considerable percentage is rendered unserviceable by the demoralization produced by the sale of liquor to natives by the canteen keepers; for, although the sale of liquor to natives is forbidden by law, this traffic is, by reason of an incompetent or corrupt police administration, one of the chief grievances of the mine officials. The supply of native labour also causes much trouble, as it does not keep pace with the ever increasing demand, caused by the opening up of new deep-level properties.

Explosives comprise dynamite, fuse, and detonators—dynamite, however, being 95 per cent. of the whole. As is well known, the supply of dynamite is in the hands of a monopolist company, the South African Explosives Company, which is controlled by the European manufacturing firm of Nobels. The present price of dynamite (No. 1), at the company's factory at Modderfontein, on the Rand, is 75 shillings per case of 50 lbs., out of which the Government receives two shillings and six pence in lieu of a share of profits. Although the price has been reduced by 10 shillings within the last eighteen months, it is still excessive; for, before the present monopoly was obtained, Nobels offered to deliver dynamite in bond at Johannesburg at 40 shillings the case, and the same people are at the present time receiving 37 shillings and 6 pence per case from the De Beers Company in Kimberley. The consumption of dynamite on the Rand is now about 250,000 cases per annum; consequently, with free trade in explosives, a saving of over £400,000 per annum might be made without reckoning the additional saving to be made on an increased consumption. Even the reduction of 10 shillings per case, which was made in May, 1898, can be of no great benefit to the industry; for it was effected by the Government abandoning the royalty of 5 shillings per case to which it was entitled under the contract, the Company conceding the other 5 shillings.* On a consumption of 250,000 cases there is a loss of £62,500 per annum, which as the Government is in want of funds, must be met by the imposition of fresh taxes in other directions.

The consumption of coal by the mines has acquired great dimensions, the tonnage sold by the collieries in the Transvaal in 1898 amounting to 1,940,000 tons, the larger part of which went to the gold mines. The average distance the coal is carried to the mines is 25½ miles, over a perfectly flat country; for this carriage the Netherlands

* That the high cost of dynamite is still a heavy burden is shown by the fact that the cost of the explosives used by the Rand mines subsidiary companies amounted to 12 per cent. of the total expenditure during 1898.

Railway Company make a charge of 4 shillings and 5 pence per ton, or 2.08 pence per ton per mile.* At the time of the investigations of the mines commission, the freight averaged 3.3 pence per mile; but the reduction, although considerable, is inadequate. Compare, in this respect, the Transvaal with the United States, where the average rate for coal transport, over all sorts of roads, is less than a halfpenny per ton per mile.†

Stores include cyanide, zinc, timber, steel, lubricants, candles, ropes, machine spares, and sundries, the cost of which is heavily increased by existing high railway rates. The same applies to machinery,

General charges comprise insurance, claim-licenses and rent, printing and advertising, and sundries. No reduction has been made under this head; on the contrary, expenditure has been increased by the imposition of a 5 per cent. tax upon the profits made by mining companies working ground other than mynpachts,‡ while companies working mynpachts are to contribute $2\frac{1}{2}$ per cent. of their gross yield. Mr. Rouliot§, President of the Johannesburg Chamber of Mines, has given the following figures illustrating the effect of the new taxes: During 1898, 28 companies obtained gold from mynpachts to the value of £5,474,787. The proportion of this accruing to the Government, being $2\frac{1}{2}$ per cent. of the gross value, would be £136,870. Regarding the 5 per cent. tax, Mr. Rouliot estimates that the figure £2,971,631 represents the total profit made by companies, exclusive of those working mynpachts. The 5 per cent. claimed by the Government would therefore be £148,580. The two new taxes thus amount together to £285,450, contributed by seventy-seven companies, having a total issued capital of £29,100,000; the new taxes therefore amount to nearly 1 per cent. on that issued capital. The increment to the cost of working amounts to 9.3 pence per ton milled. The Chamber of Mines protested against the tax on profits, on the ground that it was unnecessary and unjust; unnecessary, because a budget of $3\frac{1}{2}$ millions sterling ought to be sufficient to govern a country with a white population of less than 300,000; and unjust, because it comes in the face

* The tariff for the conveyance of coal from the collieries to the mines on the reduced scale ranges from a maximum of 3 pence to a minimum of 1.569 pence per ton per mile — Vide Chamber of Mines Report for 1898, p. 213.

† The cost of coal used by the Rand mines during 1898 was 7.7 per cent. of the total expenditure.

‡ A mynpacht is a piece of ground marked off by the original owner of the farm when it was proclaimed, being one-tenth of the amount proclaimed, and held by him under mining lease from the government. The rental was fixed at 10 shillings per morgen, but the government reserved the right to demand in lieu of this rent $2\frac{1}{2}$ per cent. of the gross yield.

§ In a speech delivered at the general meeting held on the 28th of January of this year.

of official reports* recommending reductions to the burdens pressing on the industry, which already contributes at least five-sixths of the State revenues.

Having reviewed the position of the mining industry, the question arises; what are the changes necessary to effect further economies in the cost of working, in order to improve the position, to enable those companies that are at present working at a loss to show a profit, and to allow other lower-grade properties, now lying in abeyance, to be again taken in hand and brought to a successful issue? Engineers and mine-managers have done their utmost to reduce working expenses to a minimum, and their efforts have achieved a considerable measure of success. Without assistance from the Government, however, they can do little more, but assistance means, in this case, not any artificial aid, but the removal of artificial hindrances. The most pressing reforms required are; the expropriation of the monopolist railway, the cancellation of the dynamite monopoly, the suppression of the illicit liquor traffic, and last, but not least, a voice for the Uitlander in the expenditure of the State revenues.

At the present moment the burning question of the extension of the franchise to the Uitlanders, occupies public attention to the exclusion of the other grievances. There is no doubt that many of the existing evils would find their remedy if the industrial population were admitted to an adequate representation in the governing body. At the time of writing, such representation seems as far off as ever, but until it is obtained, dissatisfaction and unrest will be rife in the Transvaal.

* The Mine Commissioners, appointed by the Government to enquire into the grievances of the industry, stated in their report that they considered it "the duty of the Government to co-operate with the mining industry and to devise measures with a view to make it possible for lower-grade mines to work at a profit, and generally to lighten the burdens of the mining industry."

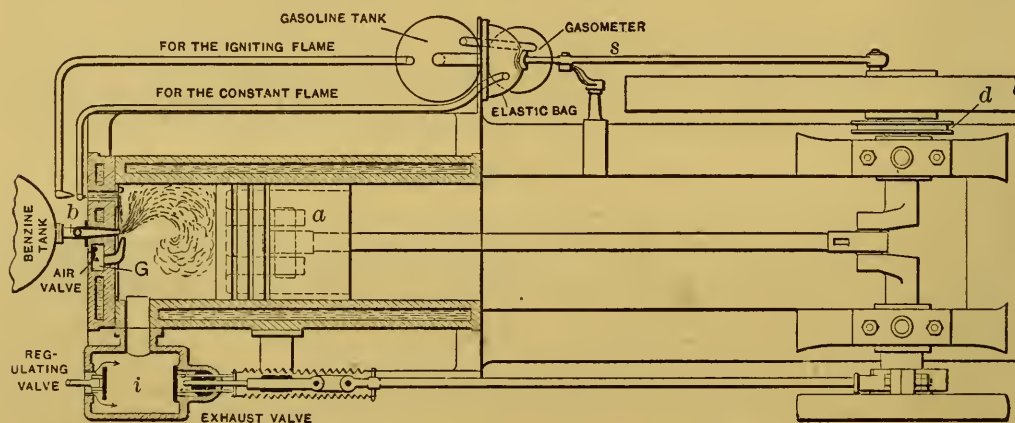
EVOLUTION AND FUTURE OF BENZINE AND PETROLEUM ENGINES.

By G. Lieckfeld.

THE inventors of the first gas engines were aware that their engines could be driven with liquid fuel, and these ideas led to the first models of benzine and petroleum engines.

In 1838 William Barrett stated in the patent specifications of his gas engine that the machine could also be driven with the volatile hydrocarbons; showing that at this early date the possibility of utilizing this form of fuel was already known. Nearly forty years passed, and it was about the year 1873 that Julius Hock, a machine builder of Vienna, began commercially to manufacture and sell a practically working and reliable benzine engine; one which was built extensively in Germany and other countries.

This was a single-acting piston engine, very similar in its action to the Lenoir gas engine. In the early part of the stroke the piston drew in atomized benzine through the nozzle *b*, and air through the valve



GENERAL ARRANGEMENT OF BENZINE MOTOR.

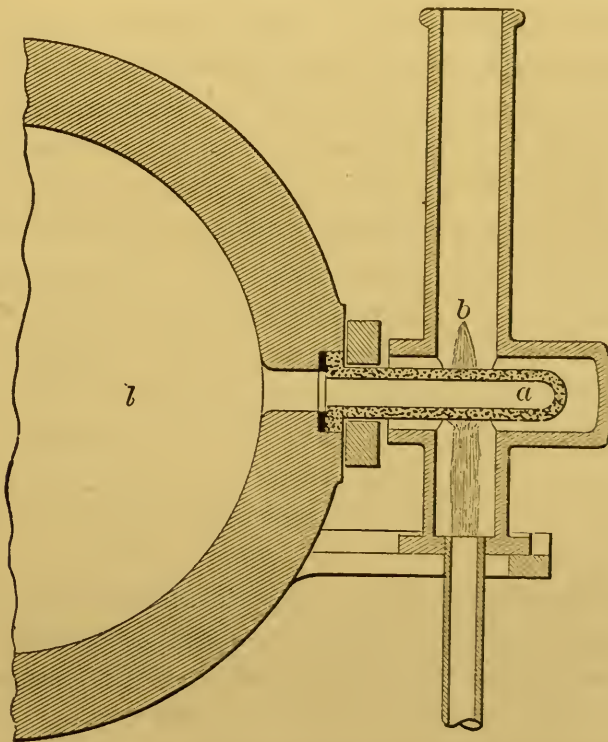
g. This mixture was ignited and the resulting explosion drove the piston to the end of its stroke. An exhaust valve then opened into the chamber *i*, and on the return stroke the products of combustion were expelled.

The Hock engine was the first of the explosion engines to use the open cylinder with direct transmission of power from piston to crank, and this form is still in general use. Although the Hock engine was

soon superseded, it had sufficient merit to serve as a model, in many respects, even for the latest compression gas engines.

The next improvement followed in 1876 with the benzine engine of the American, Brayton. In this machine, soon displaced by improved models, the mixture of benzine vapor and air was not exploded, but slowly burned behind the advancing piston. The back flash of the flame into the mixing chamber was prevented by a fine wire screen.

Very shortly after the appearance of the Otto compression gas engine attempts were made to adapt it to the use of benzine, but the



DAIMLER IGNITION TUBE.

igniting apparatus in use at that time was not a success with the liquid fuel.

Benzine engines gave no promise of success until after the invention of the ignition tube by Daimler, in Cannstatt. In all previous explosion engines the igniting apparatus was complicated and uncertain, but this striking invention of Daimler made it most simple and sure. The older form of flame ignition required constant attention, but the incandescent tube works automatically and with the greatest precision. It consists essentially of a tube, *a*, closed at one end, and with its open end fastened into the compression chamber, where the

pressure of the explosive mixture can best be depended upon. This tube *a* may be of china, nickel or platinum, and the flame applied at a predetermined spot heats it to a dull red. The interior of the tube is filled with the burnt gases of the previous charge, but when the fresh charge is compressed it is forced gradually into the tube until it reaches the heated portion and ignition follows. Contrary to what might be expected ignition is not immediately communicated inwards to the charge, but the flame burns in the tube for an interval of time, dependent on the speed of the piston. As long as compression increases, the piston not having reached the end of the stroke, a continuous fresh supply of the charge is forced into the tube, this supply being faster than the combustion within the tube. It is only when the supply of combustible is less than its consumption that the flame eats its way out, and the apparatus can be so adjusted that ignition of the whole charge occurs at the moment of maximum compression.

When the piston moves slowly in starting the engine ignition may occur too soon. This is prevented by moving the heating jet further along the tube, away from the open end. As soon as the engine is running full speed the heating jet is moved towards the compression chamber, so that perfect regulation is easily possible.

This apparatus is at once ideally simple and wholly automatic, as long as the engine runs normally. It fails, however, if the engine slows down from overloading, for in this case ignition is premature, expansion takes place before the end of the piston stroke and the engine is stopped.

In large slow-speed engines the automatic action cannot be depended on, hence a shutter, which opens automatically shortly before maximum compression, is inserted between the charge and the tube.

The story of the evolution of the benzine engine is also that of the petroleum engine, for it was very soon discovered that any benzine engine operating with the ignition tube could at once be adapted to petroleum merely by heating the inlet through which the petroleum flows, thus vaporizing the liquid on its way to the combustion chamber. In petroleum as well as in benzine engines the all important mechanism is a well designed and reliable incandescent igniter.

Owing to its volatile properties it is possible also to use benzine in piston engines built on the same theory as steam engines. Benzine engines of this type are also known as naphtha motors. In these the benzine is vaporized in special boilers, and then the expansion of this benzine vapor is used in a manner wholly analogous to the expansion of water-vapor to drive a piston, with the only difference being that

the exhaust of benzine vapor from the cylinders is used as fuel under the boilers.

The utility of this type of benzine engine is very limited, and we shall not consider them further, but pass at once to those engines in which explosion within the cylinder furnishes the motive force. Of all the internal explosive fuels benzine is one of the best. There is no other combustible, not even illuminating gas, equal to it. If it were not so dangerous and inflammable before use it would be an ideal fuel, for being a liquid it can be easily carried through pipes by gravity, or pumped to the place where needed; it is cheap (and in Germany free from tax if used for engines), the present price being eleven pfennigs per kilo. at Bremen, or about eight cents a gallon. It is easily bought everywhere in the civilized world, burns when mixed with air in very greatly varying proportions without odor, smoke or residue. Benzine engines are simple in construction, and more reliable than either gas or petroleum engines, and for the same sizes are of greater power. The only objection to them lies in the danger of storage and use of the fuel. The danger of accidental explosions of benzine vapor has been minimized, one might even say eliminated, by the use of the electric spark ignition in the combustion chamber, yet benzine has such a bad reputation that fire insurance companies frown on its use and impose many vexatious, restrictive and expensive regulations, which add to its unpopularity.

For this reason very few benzine engines are in use in buildings, a much less restricted field having been found in open air power plants, such as threshing machines, pumping engines, boats propulsion, and more recently they have been very highly perfected for automobiles. A change, however, is beginning in Germany, for in the neighborhood of Bremen, the main depot for benzine, many owners of petroleum engines are remodelling them as benzine engines, owing to its greater cheapness and convenience.

The unimportant modifications of construction in different types are generally limited to the method of air and vapor mixture. In stationary engines benzine is forced into the combustion chamber in liquid form, but in the automobiles carburetters are used which saturate the air with benzine vapor, and this mixture is then used, benzine possessing to a high degree the property of vaporizing at normal temperatures, and remaining indefinitely suspended or diffused through the air as an explosive mixture. If the surrounding air is cooler than 55° F. (12° C.) the benzine must be heated, and to start the engine a benzine or alcohol lamp is required, but, after starting, the

exhaust gases supply more than sufficient heat. If care is observed to maintain the required minimum temperature it is almost impossible for any trouble to arise from insufficient mixture.

The benzine engines used in automobiles have usually but two valves, an inlet and exhaust, and are operated with automatic incandescent-tube or electric spark, the current being provided by an accumulator or magneto-electric battery. These engines are exceedingly simple, and can be built to weigh very little, the three-quarter horse-power engine of the de Dion and Bouton tricycle weighing less than fifty pounds (22 kilos.). In order to lessen weight benzine engines have been very recently constructed for automobiles on the double-acting principle. In these the piston receives an impulse every second stroke, the forward half of the cylinder acting as air pump, compressing the air slightly, storing and discharging it into the combustion chamber of the cylinder shortly before the end of the exhaust, thus clearing it of all burnt gases. Engines of this type are twice as powerful weight for weight as those built on the single-acting principle, or Otto cycle.

With the diminution of the weight of the engine on the one hand progress has also been made, on the other hand, in avoiding the weight due to the inconvenient and heavy cooling water and cylinder jacket, by using air cooling in its stead. The rapid speed with which automobiles travel facilitates the solution of this problem. The de Dion and Bouton tricycle already mentioned is provided with an air cooler. The cylinder is furnished with a number of very deep and thin steel flanges or ribs, which offer a very large extended cooling surface to the air. Although this engine makes more than a thousand revolutions per minute it remains cool, and the lubricating oil is not carbonized. In other engines the fly-wheel is so designed as to act as ventilator, drawing over the cylinder walls a volume of air sufficient to keep the temperature down.

Passing from benzine engines we come to petroleum engines, that is, engines using a liquid fuel not vaporizing at normal temperatures. The chief fuels of this sort are the commercial brands of illuminating petroleums and solar oil, which is distilled from lignites. With these there is much less danger of fire than with benzine, and the oils are much more generally obtainable. Owing to its extreme fluidity petroleum spreads very thinly over the metal walls, and when these are of cast iron it penetrates the pores beneath the surface, and when the latter is heated the oil is very rapidly converted into vapor. When hot petroleum vapor is mixed with cold air it becomes at once a sus-

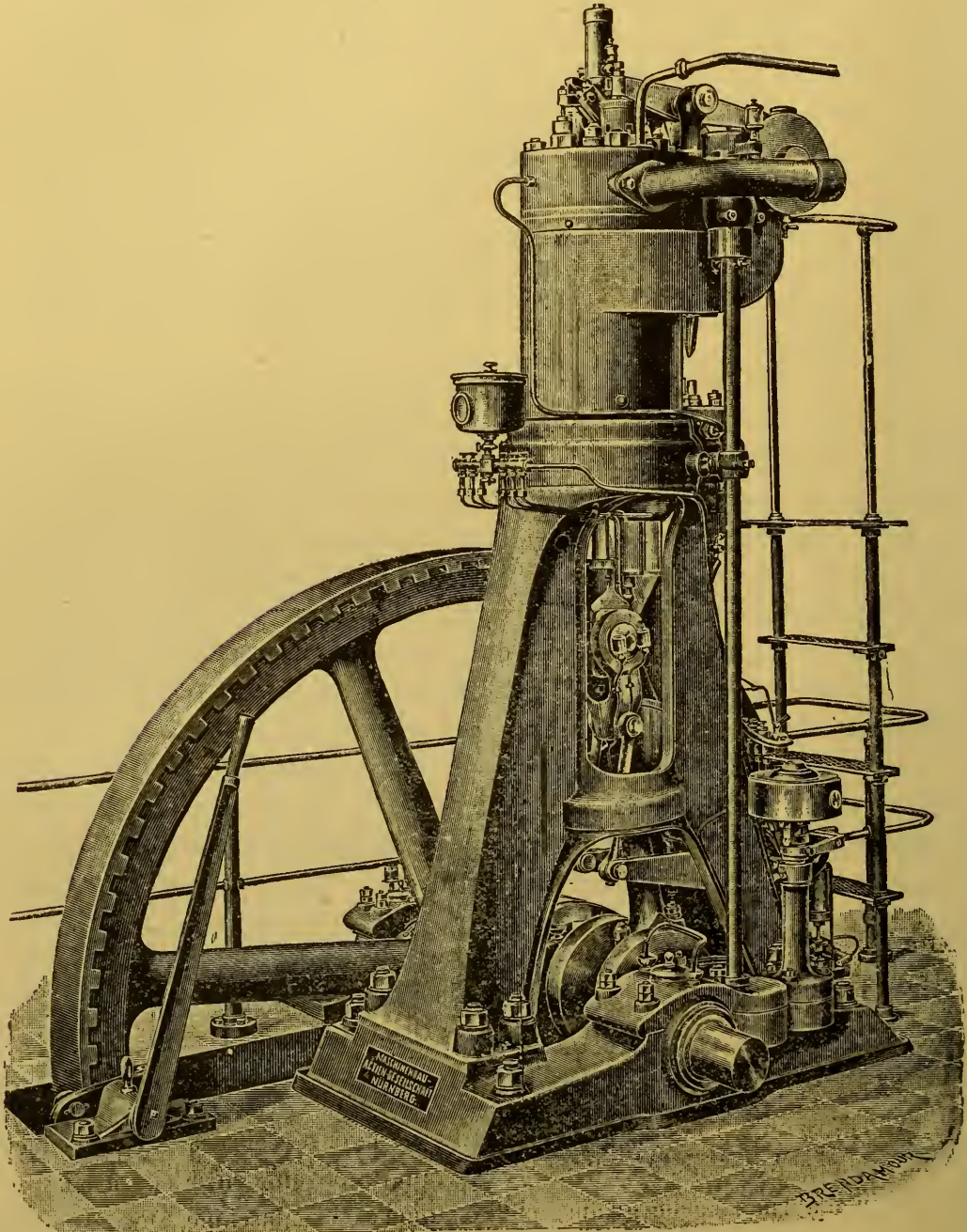
pended vapor like a fog, which when mixed with more air becomes an explosive compound, marked by a remarkably low temperature of ignition. Usually the term "ignition temperature" implies dull red heat (for illuminating gas, bright red heat), but mixtures of petroleum and air ignite at temperatures between 480° and 570° F. (250° to 300° C.). This property of petroleum vapor is very advantageous, and renders a petroleum engine more manageable than either a gas or benzine engine, but the great drawback is that mixtures of petroleum vapor and air in an internal combustion engine are not fully burnt. The exhaust is always visible as smoke, smells abominably, and will smut a sheet of white paper with spots of unburned oil. Benzine engines are first heard and then smelled, but petroleum engines offend the nostrils long before they can be heard. If noxious odors are liable to become a public nuisance petroleum engines should not be installed. This decision does not apply with the same force to open air use, and in farming operations this form of engine has very extended utility and advantages.

The danger of fire is much less with petroleum than with benzine, and with any kind of prudent care these motors are as safe as gas engines. Notwithstanding the incomplete combustion (a very small percentage of unconsumed hydro-carbons will make dense smoke and evil smell, as when the common petroleum lamp smokes), the petroleum engine costs in fuel very little more than the same powered gas and benzine engines. The normal fuel consumption is from 400 to 500 grams of oil per horse-power hour, or one gallon of oil per horse-power for six to eight hours, or in round numbers a pound of combustible per horse power, the equivalent of a pound and a half of coal.

The reason of the incomplete combustion compared to gas and benzine vapor is that both the latter diffuse in air very rapidly and completely, so that both form a perfectly uniform explosive; but with petroleum the conditions are very different. When mixed with cold air the small globules of oil form indeed a petroleum fog, but there is no molecular diffusion, and unless the air is well stirred it is hard to obtain a condition approaching mechanical diffusion, except very slowly. Distinct cloud patches of unburnt petroleum fog float off through the air in the exhaust puffs, and it is these clouds which carry the objectionable smell to a very great distance. If petroleum fog comes in contact with a cool solid it immediately condenses and shows the characteristic fluidity, an attenuated filminess. The cooled cylinder walls of the petroleum engine being colder than the minimum temperature for complete vaporizing, 480° F., a part of the fog is

condensed when the charge is drawn in, and during the succeeding explosion stroke the oil is again vaporized, but not burnt owing to lack of oxygen, and escapes as a loss with the exhaust.

Attempts to burn all the oil by some other method than premixture with air are fully justified, and it is the type of internal combustion as distinguished from the explosion motor that gives the most promise for the future.



THE DIESEL MOTOR.

In the sketch of the evolution of the gas engine internal combustion engines were mentioned. The difference between the two types, internal combustion and explosion, is fundamentally that in combustion the air is not pre-mixed with the fuel to form an explosive, but is admitted only during combustion.

The Diesel motor, named after the inventor, Mr. Rudolph Diesel, of Munich, is of this type, and he seems to have solved successfully the problem of a practical internal combustion engine. The next few years will show the real merits of this engine, and whether it can be built in indefinitely large sizes, although already large powers are obtained by coupling several engines. In the Diesel motor the atomized oil is sprayed into the previously compressed charge of air. Each globule of oil finds itself surrounded by the requisite oxygen for complete combustion, heated to the ignition point by previous compression. Absolute and complete combustion must follow if the oil has been sufficiently sprayed through the combustion chamber, in this case the cylinder. An excess of air does not interfere with combustion, and the automatically regulated quantity of oil to furnish the power required is fully consumed. In the latest trials it is claimed that this motor under full load consumed but 210 grams of oil per horse-power hour, as against a minimum of 400 grams in the explosive engines. When running under partial load fuel consumption is insignificantly greater in proportion, and this is one of the chief merits of this engine. There is also neither smoke, deposit or smell. It not only operates with half the fuel consumption but obviates the more serious objections to earlier types of petroleum engines, namely, the dirt and objectionable smell.

The illustration shows a Diesel motor, built by the Maschinenbau-Actien-Gesellschaft of Nuremberg, and exhibited at the Munich Exposition.

More recently Donát Bánki, of Budapest, has used very high compression in an explosion oil engine. His method is an injection of atomized petroleum and of atomized water. The water absorbs so much of the heat generated by compression that the ignition temperature is not reached. The danger of premature explosion is thus prevented, and the consumption of fuel is said to be remarkably low.

With these inventions of Diesel and Bánki petroleum engines are giving promise of very successful evolution, and time will show whether piston engines with initial pressures of 30 to 35 atmospheres have durability justifying commercial use. If they can be built in large sizes a brilliant future is before them. One has but to think of

their use in war and in merchant vessels, where they offer such great advantages in the instantaneous start, in the elimination of boiler weight and space, of coal bunkers, of the army of stokers and coal passers. Dangerous steam pipes can be dispensed with; there will be no funnel, for there will be no smoke, no ashes and no clinkers. Engine and furnace holds would cease to be comparable to the infernal regions, but become abodes of comfort if not of delight. The oil tanks could be located in out-of-the-way places, without taking up valuable cargo room. The fuel would flow with natural or artificial pressure to the engines. All the auxiliary engines of modern ships, used to drive the dynamos, the ventilators, the donkey engines, steam steering gear, steam capstans, cranes, etc., which consume such a large proportion of the steam, besides necessitating long and dangerous steam pipes and complicated boiler installation—all these can be advantageously replaced by petroleum engines. Everywhere, if the supply of fuel is sufficiently abundant and cheap, petroleum motors can take the place of steam engines. Coal is found very widely distributed and in abundance, while petroleum is as yet limited in supply, but it is probable that increased demand for oil will lead to increased artificial supply of liquid fuels suitable for power production.

The subject of further evolution of benzine and petroleum engines cannot be dismissed without brief consideration of the rivalry of electric motors.

Those who have followed the growth of electric science during the last twenty years, who have personally experienced the convenience of electric installations, must admit that no known form of small power engine can compete with them. There are other considerations than those of mere cheapness of fuel, in which benzine, gas and oil engines are superior. The electric motor can scarcely be called an engine—certainly not a heat engine, with its ever annoying leaky valves or pistons, for the electric motor is nothing but a transmission link, causing no worry, stopping or starting, accelerating or slowing, at the touch of a lever.

But because the electric motors occupy a field from which they cannot be driven, because there is an ever-increasing demand for them, there must also be an ever growing demand for heat engines to produce the electric current for these electric motors, and these heat engines must be ever larger and larger, more economical and convenient in operation. This demand will inevitably be filled by internal combustion engines of the explosive and combustion types.

SHORT DISTANCE ELECTRIC POWER DISTRIBUTION.

By James Swinburne.

A GENERAL introduction to the subject is all I am asked to give, so I shall attempt to touch the various branches lightly, leaving the more detailed and technical examination of the twigs to others.

Long distance transmission, especially in connection with water power and high pressures, has attracted the attention of the electrical engineer so strongly that he has not given as much thought to the apparently smaller and less important matter of local distribution of power as the subject perhaps deserves. This is to some extent because the equipment of workshops makes little noise. In such cases electric driving is generally carried out quietly by the engineers who have charge of the works, and the consulting engineer is not called in, and there is no Institution paper read anywhere, and nothing exciting happens: the machinery is merely put in and set to work. This is a great drawback; not because Institution papers are specially good things, or because consulting engineers ought specially to be encouraged, though personally of course I think they ought, but because it allows the subject to fall into the background in a way which is not warranted by its importance. The result is that most workshop engineers—I very nearly said mill-wrights, forgetting that the race is extinct now—know nothing about electrical motors, and never think of them in designing a shop. It is not that electric driving is not good enough; it is that it is never considered at all in many cases.

The most obvious places for electric motors are those in which there is a difficulty with any other method of transmission. Mining, especially coal mining, occurs at once as a good example. Higher efficiency, cheapness, safety, and practicability of the electric motor put it in the front rank at once.

The next case is where scattered steam engines are employed. Take the case of the average chemical works, for instance, or iron yard. You find a pipe supported on infrequent poles, giving a sort of cross country excursion, every day. You know it is meant to be a steam pipe because there is warm water leaking from all the joints, and that it is not lagged because it was considered that enough internal

warmth would get along the inside to prevent freezing. If you trace this pipe out, you will find it goes to a punching bear or shears, which are rattled around by a steam and warm water engine which leaks too much for the water to blow its cylinder ends off. The amount of money wasted in this way is something terrible.

In connection with docks, yards, wharves and so on, where there are many cranes, hydraulic power distribution is generally employed. Hydraulic distribution has a great advantage when the work to be done consists of moving something a short distance against a great force, as in the case of pressing, rivetting, and pressing and drawing; but in the case of lifting, the electrical system is generally more convenient. The majority of cranes in Great Britain are probably worked by local steam engines of the worst and most inefficient kind. Of course, where there are no facilities for anything like a central generating station, the electrical system is infinitely better than this, but compared with hydraulics the advantages are not so marked. One great drawback of the hydraulic system is the inefficiency. The ram has always enough pressure behind it to do the maximum work it will ever be called upon to do, and it uses a corresponding amount of energy every stroke, whether it really has any work to do or not. This extra energy goes into the water, and the inefficiency of the hydraulic system is easily gathered from the temperature of its water. As already remarked, the hydraulic system is best for slow thrusts, but when the mechanism involves gearing up, the electric motor naturally comes in even if it has to gear down. It is more efficient to gear down than up. A hydraulic capstan, for instance, is a monstrosity.

So far we have dealt with cases in which neglect of electrical transmission is a crime. We will now pass to a larger class, in which it is merely a prevalent vice. The electrical system may be compared with its competitors in order.

The motor may replace the local steam engine and boiler. That means generating on a larger and therefore more economical scale, with smaller coal and oil bills, and less labour. If the local engines to be replaced have varying loads, great economy may result, because the larger engine by averaging the load may work at an economical load always, and its maximum power may be very much less than the aggregate power of the smaller engines. The motor has a very much higher efficiency under varying loads than the engine, so there is a fair source of economy. Unless the local engines are very large, motors can replace them with great advantage in nearly all cases. As a special instance, we may take the average iron works. Here there

are large engines, generally with local boilers dotted about, each engine working one rolling mill. In the case of an ordinary engineering works, each shop has generally its own engine and boiler, involving access for coal, special labour and low economy. Going back to the iron or steel works, there is general need for some local generating plant such as the blowing engines, which work on steady and therefore economical load; and there is no reason why a power house should not be arranged at that spot for the supply of the whole system.

The next arrangement is the common vice of having a boiler which supplies one engine close to it, and feeds a distribution system of steam piping, generally very badly lagged, which supplies small engines dotted about for running saws, cranes, or large machine tools. In such cases the motor saves an enormous waste in the steam pipes, and attention is very much more economical as regards power.

The gas engine is a lively competitor of the motor when the power is supplied by a central station. If gas costs, say two shillings per thousand cubic feet, and electric energy fourpence, the cost of electrical energy comes out about six times that of gas. The difference is so great that in many cases the gas engine is better than the electric motor, though it has a varying load and takes nearly the full amount of gas always, and though it needs more attention and costs more to begin with. The real reason is that the price paid for electrical energy from the central station is enormously high, on account of the capital sunk in mains, motors and expensive sites, and on account of the expense of running and collection. In cases where the power is supplied by the consumer himself it comes out so much cheaper that gas power cannot compete with it at all.

Motor driving from public central stations is hardly developed yet. Several attempts have been made to put down large distribution systems which could supply comparatively small consumers with power at rates much lower than they could reach themselves; but the corporations always object, as they would rather generate electrical power themselves expensively than allow others to supply the public cheaply. It is probable there will soon be a swing of the pendulum in the other direction, and the rampant socialism that is prevalent will give place to better conditions. I do not exactly know what rampant or any other kind of socialism is, though I have read a good deal in order to find out. As far as I can gather, socialism consists chiefly in dissatisfaction with all possible economic conditions, coupled with an ardent desire to benefit everybody, especially the incompetent and idle, at the expense either of the capitalist if the socialist is vicious, or

of nobody in particular if he is really philanthropic. Socialism is a vague disease like general paralysis; but its chief symptom is not mere ignorance, but a negative knowledge of economics. Hence it seems rational to class municipalisation as a form of socialism. Of course municipalisation is also mixed up in some way with the labour vote, and progressivism, and trade unionism, are the chief symptoms of this variety of the disease. Coming back from isms to common sense and motors, the great development of the electrical motor will be in taking the place of the ordinary belt and shafting transmission in all kinds of factories. In such cases, for instance, as flour milling, where the machines run at constant speed and approximately constant load, the opening for electric transmission is perhaps smallest, but even in that case it will probably pay. This example is taken as perhaps the worst of its kind for electrical transmission, and even here the motor has some great advantages which may make it worth while to put in electric transmission in case of new mills even if it does not pay to change existing plant. In the first place, all the shafting and belting is taken away and lighter buildings are necessary. Smooth working and silent running is obtained, and the efficiency is certainly increased, that is to say, smaller engine power is needed.

In the case of cotton spinning, the same reasoning applies. The electric motor has here a very special advantage. A properly designed shunt machine runs at constant speed not only with varying load, but also under varying pressure, so that the machinery can run at constant speed even though the driving engine varies considerably.

The driving of machine tools by motors has perhaps received more attention than all the other applications of small motors put together. As a rule engineers arrange their own shops in a way which they would be ashamed to adopt in filling an order. There is no doubt that all tools can be best driven by motors, the only question that is open is, whether each tool should have its own motor, or whether several small tools, such as lathes, shall have a shaft and one motor for the lot. The only other question of difficulty is to choose between direct current and the polyphase system. The absence of all noise from a shop is in itself by no means a particularly sentimental consideration; the disappearance of all overhead shafting has thus an advantage apart from the fitness for overhead cranes, and even small overhead runners. The small motor is, however, much less efficient than frequently supposed. There is a common idea that all dynamos and motors run up to high efficiencies, say 95 per cent. or so, but small motors are much more likely to be of the order of 59 per cent. The

initial expense of small motors is their chief attribute, however, and in addition to this, machine tools are not designed for motors to begin with, but the maker sticks it on where he can under protest, and treats it as an architect does a church organ, as an unavoidable evil, which has to be tolerated, but must not be considered. A great part of the cost of the small motor is the frame work and bearings, and if the machine tool were properly designed, and the motor made by the tool maker, this cost would be saved, for the motor and frame would take the place of the bearings and framework of other motion or reduction gear employed in connection with belt driving. At present the motor is bought as a complete mechanism from some electrical works.

Next as to varying speeds. As automatic tools come into more general use, the need for wide variations of speed become unnecessary. But in most cases variations of speed are required, and the old pulleys are kept in the machine. Probably the simplest method of getting various speeds in direct current systems is by having several mains. Thus, a four wire system having 30, 60, and 120 volts gives speed ratios of 1, 2, 3, 4, 6, and 7, which is much more than most speed pulleys. The field magnets are always fully excited by the 210 volts across the outers, and the armature takes the various pressures. This system gives good economy and is simple, and it costs little extra to run four wires instead of two. The question of speed is not so easily dealt with in the case of polyphase machines, as it is necessary there to have several sets of mains with different frequencies as well as different pressures, or to have more or less complicated methods of coupling the inducing element.

One of the greatest, and perhaps the least recognised advantages of electrical driving without shafting is that as each machine is self-contained, the ordinary foundations can be left out. A lathe or any other tool if decently designed, does not depend on the foundations for rigidity; the only thing the foundations do is to take up the shake communicated from outside by the belts. A self contained machine runs better the less it is fastened down, or to take Mr. Beaumont's motto, "If the mechanism wants to wobble, let it wobble." The stresses on all the parts, for instance, of a badly balanced mechanism are less if the framework is not fixed to any foundations. The saving of foundations and belting as well as shafting should be credited to the motor, and the saving in wear and tear of the belting, as well as in mere coal and oil, should also be credited to the motor's running account.

In all sorts of portable tools, such as drilling, rivetting, power

chipping, power caulking, countersinking, and tapping, the motor is far away ahead of compressed air, steam, rotating spirals or any other systems; and there is no reason why portable riveters and punches should not be driven electrically too.

On board ship, there is a large opportunity for the introduction of electric control of steering gear, capstans, winches, pumps, and all sorts of discharging gear. In men-of-war electricity is also applicable for working the guns, turrets, loading gear, and similar mechanisms. One obvious advantage is that the transmission system, namely, the mains, can be very easily arranged in duplicate, so that a shot is not so likely to cause disablement.

EDITORIAL COMMENT

The Conferences of the Institution of Civil Engineers, and the excursions in connection with them, abundantly illustrated the wide range of the profession in Great Britain, where differentiation has not gone so far as an attempt to make half a dozen kinds of engineering, each distinct and all co-equal. The idea still obtains that all engineering which is not "military" is "civil"; with the enormous increase in the perfection and the use of mechanical appliances, all modern engineering is certainly mechanical; and it meets but a slight hyperbole to say that now-a-days it is all electrical. Any further classification is of province or purpose—not of practice. The range is now so wide that it is expedient to specialise in work, as it is convenient to classify engineering literature, under many departments; but all parts are so interdependent that it is well to keep the common bond and the common meeting ground.

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Those who were fortunate enough to accompany the Institution on the visit to Crewe had an opportunity to study a works typical of the comprehensive British practice, in antithesis to the specialising American practice which is now so much under discussion. The one aims at covering as many as possible of the stages of manufacture which separate the raw material from the finished machine; the other seeks subdivision of processes, distribution of operations, and concentration upon as few as possible in any one establishment. The one strives for economy by collecting into the one treasury the profits of the largest practicable number of industrial operations contributing to the finished work; the other is directed to the effort to cheapen production by collecting into the one works the largest practicable volume of work of specialised character, and lowering the cost of that by standardising, by the use of special machinery, and by intensified production.

Thus the Crewe works really display almost every operation connected with the

production of railway material and supplies—for equipment, line, signal systems, or buildings—reaching as far back even as the Bessemer converter and the open hearth furnace. The typical American railway shops, on the other hand, are essentially for repairs and maintenance of equipment, with enough new building of locomotives or coaches only to furnish stability in working. Possibly it would be fair to estimate that the largest American roads do not build more than one-third of their engines in their own shops, and never dream of any other course than buying rails, boiler plate, steel bars, structural shapes, or signal apparatus from outside establishments.

We may safely leave our contributors to discuss the two systems from the standpoint of their respective claims to the maintenance of stability and the furtherance of economy. It is of interest, however, to point out that the British policy, while apparently making the railways very independent up to a certain point, leaves them curiously helpless when the demand for engines exceeds their own building capacity; for they have not, by steady support, built up a strong outside locomotive-building industry such as that which has been developed under the American policy and has enabled the United States to enter markets where their competition was least expected.

* * *

In the debate upon the respective merits of British, Continental and American machine shop practice, generalisation as to the national characteristics displayed either by workmen or managers, must be qualified by the recollection that there has been a free interchange between the great industrial nations during recent years. Many Americans may be found in German works; conversely, many English, Scotch, German and Swedish foremen and managers are directing American engineering establishments. The Clyde and the Tyne have been drawn upon for the personnel of foreign yards, and marine and mechanical triumphs

accomplished under other flags might often trace their heritage to British ancestry. The greatest study for Great Britain to-day is the industrial policy which will give the fullest play and the largest reward to her industrial talent at home. She must not be slower than her rivals to incorporate into her own system the best that can be found anywhere, either in engineering practice or in industrial policy.

It is the aim and the constant effort of THE ENGINEERING MAGAZINE to further industrial advance by setting forth the work and the thought of authorities and critics of the highest standing and the widest international experience.

* * *

An American paper, commenting upon the introduction of American engines upon British railways, rejoices especially over the value they will have to the English public as models of higher æsthetics in locomotive building.

There will be more than one opinion on this point. Aesthetics, hardly less than theology, have always been the domain of absolute dogmatism—and yet there is hardly any field in which the accustomed is more likely to be confused with the absolute. But it would hardly do to say there is no absolute standard of beauty in machinery, and it would be interesting to know how many years of custom it would take to reconcile one to the lines of some of the Continental engines. Take, for example, those Belgian locomotives with a square smokestack, and behind it a series of protuberances on the boiler, gradually diminishing in size as one proceeds toward the foot plate, giving the general effect of a giraffe equipped with the running gear of a dachshund—surely, though they may be very useful, even their makers can hardly believe them to be beautiful.

The American designer has not been so closely limited as the British designer has, either in height or breadth. With more generous proportions, he has kept his lines simpler and made his machine heavier, following the tendency which is even more strongly manifested in the American railway carriages. One of the greatest English engine builders recently deplored the appearance of the same movement in Great Britain. It seems inseparable from the de-

mands of the traffic department for more luxurious carriages, higher speeds and longer runs. The more credit to British locomotive designers that they have met every such demand, while working always within the narrow limits fixed by existing height of tunnels and widths between platforms.

* * *

It is proverbially unsafe to assume that that which follows is necessarily consequent upon that which precedes. Without further study, therefore, it will not quite do to assume that the recent heavy decline in American exports is a result of the trust-forming mania which has raged in the United States for some time past. It has, however, been pointed out frequently in these columns that a loss of foreign trade to the United States was reasonably to be expected as a result of some of the "combines"—such, particularly, as could have no object but the maintenance of high selling prices.

That the immediate decline of American sales is probably, in part at least, an effect of the trust-disease is suggested by a recent paragraph, stating that a British firm had obtained an order for 300 tons of guard rails for the Boston, U. S. A., overhead railway, and that the fish plates were to be supplied by another British maker, both orders having been placed in England, to the buyers' considerable advantage, because American manufacturers had combined to keep up prices and had overdone the thing.

Until the United States settles the industrial system upon the broad and stable basis of a sound political economy, American manufacturers will struggle against heavy disadvantages in the markets of the world.

* * *

Affairs in South Africa furnish another instance of the fact—often referred to in these pages—that politics, and especially international politics, are becoming of more and more importance to the engineer, because they are more and more based upon industrial and economic questions of vital concern to his work.

In the case of the Transvaal the political phase has been so largely developed of late that the real issue is in danger of being hid-

den. It is most gratifying to be able to secure so high an authority as Dr. Hatch to restate the propositions upon which the whole matter depends. It is not the oppression of a small power by a great one, but the oppression, by an obstinate and dull sighted government, of an industry which, by the nature of the case, is wholly in its power. Boer apologists assert that the Republic did not care to have the mines opened—they merely permitted the working under conditions which were accepted, and should not now be disputed by the miners.

As a matter of fact, the conditions have been changed repeatedly to the disadvantage of the industry. The Boer government has shown a settled determination to allow nothing to limit its greed in extorting the last penny which can be wrung from the mines; and its eagerness to receive and expend the revenue they bring in fits ill with its protestations of longing for the pastoral peace—and bankruptcy—which existed before the reefs were worked.

The "weaker power" is the mining industry, striving manfully to help itself so far as good practice can go. The interest of the engineering and economic world demands that good government and a liberal industrial policy be brought to supplement the miners' own efforts.

Dr. Hatch speaks the dispassionate opinion of the mining and geological expert. He has not been identified with the political agitation in the Transvaal, and his conclusions have no tinge of the bitterness which might cling to the disappointed reformer. But they carry the authority of his thorough study and his intimate and immediate knowledge of the natural and economic condition of the field.

* * *

The water-tube boiler is certainly taking a place among the living and striving growths of modern engineering when a London evening daily opens its columns to a discussion of the pros and cons. The strong popular interest in the navy may warrant a departure which seems extreme for daily journalism—although industrial topics are gradually taking a larger and larger place in the lighter forms, even, of current literature. It is doubtful, however, if this particular discussion is going to introduce into the argument anything except

a flavour of extreme bitterness. The case is not being tried by proper advocates nor in a competent court; the proceedings are irregular and the verdict, if any be reached, will have no force.

Probably a fair statement at present is that the many and great advantages of the type have stimulated many attempts to solve the problem of design, most of which lack entire completeness, or miss entire perfection, in some one point. Marine service—the severest, probably, which can be conceived—demonstrates the defect far more conspicuously than the excellence. The demonstration is made in a glare of publicity to begin with. The opponents of each type add the searchlight of investigating criticism and proclaim their condemnation with the bell of the town crier.

Meantime the designers, profiting more from the failure than from the success, are going steadily on to remove the defective details and to increase the general excellence. Some types, at least, have demonstrated their high economy and efficiency throughout a remarkable range of duty-requirements. For many classes of service, the water-tube boiler is admitted to be the only acceptable type; its adaptation to larger units and its introduction to the merchant marine may be regarded as certainties in the very near future.

* * *

In the entertaining account of the construction of the various routes to the Klondike gold fields given by Mr. Harrington Emerson in another place in this issue, the construction of the White Pass and Yukon Railway is described as completed to the summit of the White Pass. From that point to the waters of the Yukon the journey affords no insuperable obstacles, and hence railway traffic at once began when the summit was reached. Since Mr. Emerson left Alaska, however, work upon the railway has been steadily continued, and on July 6, 1899, rail communication was opened as far as Lake Bennett. Although the road is to be continued to Fort Selkirk, yet the continuous railway from Dyea to Lake Bennett practically opens up the whole of the Klondike country to the rest of the world, and removes all hardship as far as travel is concerned. The passenger

from Seattle or Vancouver can now proceed by boat to Dyea, where he takes the train over the White Pass to Lake Bennett, and from thence proceeds by boat down the Yukon to Dawson without difficulty or delay. The natural result will be a transformation similar to that which has taken place in other mining regions so soon as transportation facilities have been provided. Where there is gold to come out the products of civilized life will flow in. Labor conditions will become equalized, scientific and technical methods of work will be adopted, and mining in Alaska will become what it has become in other parts of the world, a legitimate business instead of a gambling hazard.

* * *

It is rather interesting to note the contest which is incessantly being waged between land and water transport in every part of the world. One does not have to turn to the American isthmus to find evidence of this. When bodies of water divide countries (or, as has been better said, when they unite them), plans are made without number for bridges to span them or tunnels to bore under them, as witness the proposed tunnels between France and

England, between England and Ireland, and between Spain and Africa.

A noteworthy example of the reverse is seen in the contest between land and water transport in Southern Europe, as reviewed at length elsewhere. When the Alps maintained their rocky barrier between Italy and the rest of Europe, trade naturally and freely flowed around by way of the sea. Since the mountains have been pierced, and rapid land transport established, every energy on the part of the people and places interested in the older line of trade has been exerted to regain the lost pre-eminence and combat successfully the overland routes.

It is but natural that local interests should struggle for self-preservation, but there can be little doubt that there is room for both systems in many places, although not to the prejudiced eyes of interested persons. For this reason it appears to the distant outside observer as if each branch of commerce should be distinctly judged upon its merits apart from purely local considerations, the work of the engineer being called upon to build up the natural advantages of one locality without designedly destroying those of another.

REVIEW OF THE BRITISH PRESS

The Conference of the Institution of Civil Engineers.

THE Second Biennial Conference of the Institution of Civil Engineers produced such a wealth of papers upon all branches of engineering that it is impossible to review them at length, and the interested reader must be referred to the columns of both *The Engineer* and *Engineering*, in which the transactions are most fully recorded. At the same time, a review of the conference as a whole may be given here, at least as a tribute to a most noteworthy gathering, and possibly also as an indication of the general trend of the proceedings and of the work which was done.

Two things especially are to be noted about the conference, one being the subdivision of the work among sections devoted to distinct branches of engineering; the other being the condensed brevity of the papers, by which a great amount of valuable matter was presented in a form best adapted to the occasion. The idea of subdivision into sections is not new, but it is certainly good. Both the British and the American Associations for the Advancement of Science have found it advisable to divide the work in order that it may be more successfully attacked, and the same plan has been adopted at the professional congresses which have been held at the various international exhibitions. The condensation of the papers proved advantageous or otherwise according to the facility possessed by the author in so treating his work, but in the main the result was satisfactory.

The subdivision of the work of the conference was into seven sections, as follows: I., Railways; II., Harbours, Docks, and Canals; III., Machinery; IV., Mining and Metallurgy; V., Shipbuilding; VI., Waterworks, Sewerage, and Gas Works; VII., Application of Electricity.

Taking up very briefly the work of these several sections in order, the papers before the first section dealt mainly with two subjects; special railways for light service or

mountain traffic, and methods of railway signalling. In the first subject the most important point brought out was the importance of adhering to the standard gauge for all purposes, there being little or no economy in narrow gauge; while in connection with the second subject it was shown to be most desirable that railways which used any portion of road in common should use the same systems of signalling, as otherwise confusion might be expected. Papers upon earth-slips, upon handling and transport of minerals, and upon relaying railway track were also presented.

In the second section some important papers were read, notably one upon the discharge and reloading of steamers, and one upon grading docks. The great increase in the size and capacity of steamers is causing correspondingly increased demands to be made both upon the dimensions of docks and upon the capacity of handling machinery, while the limitations of the depth of water over the bar in important harbors makes a limit to the draught of vessels which can only be extended by important harbor improvements.

A portion of the papers in the third section related to railway work in its department of motive power, compound locomotives for main line service, and various motors for light railways and for automobiles both being discussed. In machine work proper we may note papers upon English machine tools as compared with American and German practice, as well as those upon the best motive power for use with cranes. Papers upon condensing plants and upon forging machinery were also presented.

In mining and metallurgy the attention was divided between steel making and coal and gold mining. Some valuable tables of color temperatures and of melting points as determined by the Le Chatelier pyrometer, were given by Mr. Hadfield, and interesting information about problems and methods in the Transvaal by Mr. Irvine.

The fifth section, devoted to shipbuilding,

contained several papers which bore upon the discussions upon harbors and docks, the increasing size of vessels being a fertile theme. The question of the use of merchant vessels as auxiliary cruisers was also brought up, doubtless stimulated by the experiences of the Spanish-American war.

Among the papers in the sixth section, which may be considered as relating practically to problems in municipal engineering, the most important related to sewage disposal and to water supply. In the latter subject the question of waste of water received especial consideration, and indeed this bids fair to become an important municipal problem everywhere.

In the electrical section the mechanical side of electrical engineering received the greater share of attention, long distance transmission, as well as transformation, being discussed, to which also the subject of mechanical traction by electricity and the construction of electric meters formed excellent adjuncts. Judging from the importance of the subjects presented to the various sections and the professional eminence of the authors, the conference was an undoubted success, and a close perusal of the papers shows the great value of the varied mass of information thus gathered.

It is an unfortunate consequence, however, of the attempt to combine technical discussions with excursions and social entertainments, that the discussions are sure to suffer. Papers such as those to which reference has been made should have elicited such discussions from the audiences to which they were presented as would have added much to the value of the information contained in them. In very many cases, on the contrary, the discussions were cut short because the time for some excursion was pressing close, and the debate suffered accordingly. This great loss might well have been avoided by the presentation of written discussions by title, supplemented by written comments added after the conference, the text of the original papers being placed in the hands of all members in advance. Even with this drawback the conference of 1899 will be remembered as a most important professional and social gathering, while the record, in the form of the many valuable papers, will mark the contribution to applied science.

Science and Engineering.

IN his opening address before the Conference of the Institution of Civil Engineers the president, Sir W. H. Preece, made some very apt remarks about the relation of science to practice within the realm of engineering. Many years ago Lord Brougham defined science as "Knowledge reduced to a system," and in this definition Sir W. H. Preece followed him very closely.

"Science, a much abused term, is the systematised collection of the facts and laws of nature, and engineering is their practical application to the use and convenience of man. There is a great tendency to put the cart before the horse. Science has followed, it has not led engineering. It is their intimate association which is the foundation of all industrial progress. The war of the microbes, the latest development of biology, is a consequence of sanitary requirements. Our knowledge of the diffusion of molecules and the solution of solids has sprung from the investigation into the mechanical properties and constitution of iron and its alloys; and the disturbances of the ether are becoming familiar through the practice of the so-called wireless telegraphy. Facts are derived from accident, observation or practice; laws are the result of research. Engineers have always appreciated science up to the hilt, but they wish that its special votaries were less dogmatic and more modest."

Some good points were made in the address concerning the possibility of rightly conferring degrees in engineering. This practice, followed by some educational institutions, has always been deprecated by the Council of the Institution of Civil Engineers. "Every engineer must acquire a knowledge of the scientific principles and the mental tools that form the bases and aid the operations of his profession, but he can become an engineer only by becoming an expert in its practice."

The truth of this position will be admitted by every practicing engineer, and there are few indeed who will maintain that a knowledge of the profession of engineering can be attained without the hard training which comes only by practical experience. Beneath this, however, must be laid the broad foundation of sound knowledge of fundamental principles, a knowledge so thorough-

ly ingrained as to become almost intuitive, and which may be depended upon to reveal any fallacy which may be concealed beneath a plausible exterior.

It is the combination between science and practice which makes the truly successful engineer, and in developing such a combination organisations like the Institution of Civil Engineers are most efficient instruments. It avails but little for the purely theoretical man to develop some subject in defiance of the conditions which obtain in actual practice when he sees before him as he reads his paper men who know of their own hard experience wherein the fatal weaknesses of his treatment lie, while on the contrary, no man dare sustain a position contrary to the admitted laws of nature before those who can see through such fallacies at a glance.

Successful engineering is always composed of the intelligent union of science and practice, and the scientific man who knows how to be practical, and the practical man who is willing to be scientific, can meet on common ground in the broad field of engineering.

English and American Workmen.

IN the course of some interesting comments on the different manner in which English and American workmen regard the introduction of labour-saving machinery, *The Engineer* shows that the only true solution of the problem of the congested state of English machine works lies in doing the very thing which the men are unwilling to permit. "The solution of the difficulty obviously lies in augmenting our production. We must build three locomotives where we now build two, and so on; but this can only be done by augmenting the productive power of the workmen. We cannot put on three men where there are now two; machinery must come to our aid."

Reference was made to a machine-riveting plant used in the United States, which saved 50 per cent. in labour, thus enabling one man to do the work of two. If such a plant were put in use in Great Britain the probabilities are that the men would refuse to have it.

"Such a policy will, of course, in the long run be suicidal; and, in any case, the machinery will take its place in our shipyards

on its merits, just as all other machinery—such as the power loom and the boot-making machines—come to stay. But the question which presents itself as most pressing at this moment is not the future of any machine, or system of construction, but why should the working engineer in the United States be so different from the working engineer in this country?"

There is no doubt that the difference does exist, not only between the English and the American workman, but also between the English workman transplanted to America and his brother who has remained at home. It cannot, therefore, be a question of race; it must be a question of environment. In the United States the present and future surroundings of the capable machinist have much to do with the marked individuality which he possesses, or soon acquires. He has no idea of always remaining a machinist; on the contrary, he aspires to become a foreman, superintendent, manager, or even proprietor. As a result he takes an interest in his work, not merely for the direct value of the wages he is to receive, but also because he sees a future ahead of him which will lead to better things if he is capable of grasping them.

As a well-known American writer, himself an example of the truth of his own words, once wrote: "The comforts of life and home are within the reach of all American workingmen. The best of all things that are printed, the finest efforts of the stage, and the best of home comforts the American workman may enjoy. There is no social bar whatever to his political distinction. He may choose whether he will frequent the finest homes in the land or the lowest pot houses. Every prospect for the future which this wide world holds out for its choicest people the land holds out for the capable mechanic. Yet the shiftless, ignorant, thoughtless sluggard sees no show for the workingman. There is a show, *all* the show, but maybe none for him. The sensible mechanic don't gauge his own accomplishments by the contemptible lack of effort of the ignorant howler."

When a workman really begins to feel his individuality, and realises that he is not merely a member of a class, he also feels that his opportunity to rise must be made by his own efforts, and that so far from ex-

tra effort acting to reduce his opportunity for employment it really aids him to obtain a better and higher position. He is therefore quite willing to welcome the advent of labour-saving machinery, understanding that it is often labour-making machinery as well, and that while it may diminish the demand for labour of some kinds, it will increase it for that of other and higher kinds, much of which will fall to his share if he show himself worthy.

It is this opportunity for individual development which produces the independence of the workman in America, whatever be his origin, and in such an atmosphere the trade restrictions of unions and organisations fail to hold and control the best and ablest men. Labour unions there are, with arbitrary rules and extensive membership, but the most skillful machinists know that they can prosper far better by their individual efforts than by any such organisations, and it is largely if not altogether to this fact that the difference between the machinist in the United States and in Europe is due.

Separate Condensing Plants.

THE progress in various details of steam engineering is not always as rapid as some would have us believe, and it is curious to note how sometimes ideas which should be most obvious are not perceived until after many years.

The great impetus given to the development of the steam engine by Watt was mainly due to his invention of the separate condenser, which converted the wasteful engine of Newcomen into a serviceable and economical machine, but although subsequent builders soon added to the vacuum of the condenser the higher steam pressures which improved boilers made possible, Watt himself never encouraged the use of high-pressure steam but always preferred to depend principally upon the vacuum produced in the separate condenser for the power produced in his steam engines.

Until very recently the apparently obvious idea of extending the separate condenser idea to include the discharge of several engines into a single "central" condenser does not appear to have occurred to anyone, but during the past few years this extension of Watt's original invention has been made with decided success, and a

number of such central condensing plants have been installed, especially in Germany.

This subject was discussed at the recent Conference of the Institution of Civil Engineers in a paper presented by Sir Alfred Searle Haslam, in which the advantages obtained by the use of a central condensing plant were fully set forth.

"The older system adopted was the application of a condenser to each separate large engine, leaving the medium and small size engines without condensers, but in many modern installations, where a large number of various size engines are used in connection with the works, or more particularly in electric light stations, it is found advisable to have one large condenser to receive the steam from the various engines which may be distributed over the works or installations. In cases where this arrangement is not carried out, a large number of engines are frequently left unprovided with a condenser, the result being increased working expenses in coal consumption. A large condenser tends to economy and efficiency, also a reduction in first cost and economy in maintenance. Very careful tests have been made at factories where engines have been worked without condensers, and by the application of a condenser common to a large number of engines, an economy has been secured amounting to 20 per cent. or 30 per cent. of the coal consumption.

"On board ship these condensers are found to be of immense value. The old practice was to convey steam to the condenser of the main engines, but when the steamer is in port and the main engines are not at work, the auxiliary engines for electric light, refrigerating machinery, winches, cranes, and various engines used on board ships must either work high-pressure or exhaust into the main condenser without a vacuum. By having a separate condenser fitted with an air pump, and into which all the various engines can exhaust their steam, the condensed steam is available for feeding the boilers, the efficiency of the engines is maintained, and a reduction in the coal consumption is the result."

The style of condenser to be adopted for a central plant necessarily depends upon the location. On shipboard the usual form of tubular surface-condenser is naturally used, but for manufacturing establishments

or electrical plants the question of water supply must be considered. Where water is abundant surface condensers will generally be employed, except when the supply is pure enough to be satisfactory for direct use in the boilers, in which case there is no objection to the use of injection condensers, the simplicity of the apparatus and the high vacuum attainable being points worthy of consideration. Where water is scarce, however, it becomes necessary to resort to some means by which it may be economized, and it is the demand for a condenser which is capable of maintaining a good vacuum with a minimum supply of water which has led to the design of cooling towers, evaporative condensers, and similar devices.

Theoretically, the evaporative condenser offers many advantages, since, all other things being equal, the condensation should be effected by the evaporation on the outside of the tubes of a quantity of water equal to that condensed within them. Here, however, as in many similar cases, all other things are not equal, and previously neglected questions, such as the influence of atmospheric humidity, deposition of dissolved salts, etc., etc., crop out to the inconvenience of the engineer. These, however, are minor features, and will doubtless be successfully overcome, and there is every reason to believe that the great heat-absorbing process of evaporation will more and more be called upon to assist in the condensation of steam. At the same time other devices will doubtless come into use, and before a very great while it will be the rule, rather than the exception, for every power plant of reasonable size to be equipped with a central condenser.

The Handling of High Explosives.

THE general introduction of high explosives into use in coal mines in the place of gunpowder has been mainly due to the desirability of avoiding the use of any explosive which may ignite the mine gases, safety being the great point to be attained. There is little doubt that so far as the ignition of firedamp is concerned, the modern explosives are much safer than the old one, but there are other dangers connected with their use which can only be avoided by care and proper supervision. It is of these latter

dangers that a carefully written article in recent issues of the *Colliery Guardian* treats, and some of the points are so eminently sensible that they should be emphasized to the utmost.

In the first place, proper care should be given to the storage of explosives, not only with regard to absence of moisture, but also to freedom from marked variations in temperature that decompositions and alterations in character are due. All explosives should be kept in the main storehouse, and not given out to the men in such quantities as will oblige the latter to find some place of their own to keep the surplus until used.

A very important feature is the careful accounting of the whereabouts of all explosives and especially of all detonators. If every miner is charged with the exact number of cartridges and detonators given out to him, and obliged to account for them, or for an equivalent number of explosions, much will be done to insure safety. With such a record accurately kept, there is no difficulty in discovering who the careless individual may be who has allowed dangerous materials to get into irresponsible hands, while the reprehensible practice of using more than one detonator to a charge would be promptly checked. So far as the care of stock is concerned, then, the main points to be observed are to have a dry, well protected place of uniform temperature for storage, under the care of a competent person, and to have every charge accounted for, only giving out each day the estimated quantity required for that day's work and requiring all excess to be accounted for regularly.

In regard to the use of high explosives the same common-sense rule of carefulness should apply. The charge may be prepared a short time before the hole is ready for it, but under no circumstances should the detonator be attached until the last moment. Especial care should be given to the cleaning of the hole, for unless all drillings and cuttings are removed, the cartridge is liable to stick on being inserted. The size of cartridges should be adapted to the diameter of the hole, since cartridges which are too small for the bore are apt to get canted and caught, several thus forming a sort of toggle series which is very apt to jam.

The stemming material should be stiff clay, formed into plugs or cylinders, inserted into the hole and forced into place by firm quiet pressure, blows being altogether forbidden; six inches of such stemming being quite sufficient. When a short stemming is used, there is enough depth of hole left to permit a second charge to be put in and fired should the first charge miss fire.

Every missed shot and unexploded detonator must be recovered. The practice of rolling into the pack blocks known to contain unexploded charges should never be permitted, and a piece of coal containing a missed charge may, if put into the gob, be a cause of a most disastrous fire. The handling of missed shots is best intrusted to a special man, who by acquiring experience in this difficult line will best know how to deal with the various cases which may arise. If the hole has only a short stemming, as described above, a second charge will, in nearly every case, explode the first. If this is not successful a second hole may be drilled, and an experienced man will have no difficulty in determining whether both charges have gone off.

There is a legal requirement, which should be enforced rigorously at every mine, that if a man leaves his place with a missed and unrecovered shot therein, the place must be fenced off, and the incident reported to the authorities.

While the various points thus made regarding the handling of high explosives may seem very elementary, it is by the non-observance of just such simple precautions that the greatest disasters are caused, while with a reasonable degree of care, safety may be practically assured.

Steam Pipes and Fittings.

AMONG the papers presented at the Bristol convention of the Municipal Electrical Association was one by Mr. J. E. Edgcombe upon the arrangement of steam pipes and fittings, which contains some points of interest. It is an excellent example of the close relation which mechanical and electrical engineering bear to each other that a paper so strictly mechanical should have been presented at an electrical convention, but as Mr. Edgcombe said:

"The subject of steam and other piping is one of the greatest importance to engineers of central stations, and indeed, to all who have to deal with steam plant." Since electrical plants are in nearly every case also steam plants, except in those favoured localities where water-power is abundant, the electrical engineer needs to learn all he can about these important details of his work.

The piping system which must be considered in a power station is mainly that which connects the steam boilers with the engines, and as in most case the boilers are placed in a portion of the building adjoining the engine room, the connection may be made in a very direct manner. Mr. Edgcombe expressed himself in favour of the so-called "ring" system, in which the steam main forms a steam-ring running from the boiler house through the engine house and returns again to the boiler rooms where it connects with the starting point. All the boilers, in this system, connect into this ring main, and all the engines draw from it, and by having valves placed between every unit, any single unit or series of adjacent units may be cut out of action without requiring the others to be stopped. The ring system, however, was not given the unqualified endorsement of all those who discussed the paper, and Mr. Ferranti expressed himself as decidedly opposed to this arrangement, involving as it does a great number of valves and connections. He gave preference to the system of running the plant in independent sections, each section consisting of one engine and the boilers necessary to drive it.

The importance of giving attention to the valves was also discussed and some valuable practical points elicited. One of the most frequent causes of trouble with valves lies in the carelessness which permits dirt, chippings, etc., to be left in the piping when it is first connected up, as this matter is gradually carried along with the current and lodges upon the valve faces, causing cutting and injury; no small portion of the leakage so common with steam valves may be traced to this cause.

The question of expansion and contraction is always an important one in connection with long lengths of piping, and not-

withstanding the attention which has been given to expansion joints it appears that no wholly satisfactory method of providing for the expansion of steam pipes under pressure has yet been devised. Packed stuffing-box joints gradually become hard and rigid, and better results are obtained by using copper expansion bends, but the increasing use of high-pressure steam brings in the uncertain element of the diminution in strength of copper under high temperatures.

In electric plants the great thing is the necessity of maintaining the plant in operation, at least partially, under all circumstances, and the possibility of a complete stoppage ought to be most remote. For this reason it should be possible to throw any boiler or engine out of service without interfering with the others, and should a pipe burst or a valve fail, the loss of steam should be automatically checked. Valves for this purpose are made, and, when placed between the boilers and the steam main, these close when any great difference in the equilibrium on either side occurs.

The great remedy for trouble with steam piping lies in frequent and careful inspection. Valves should often be opened and tried, pipe hangers and supports examined to see that expansion strains are not working injury, while any symptom of leakage at flange joints or stuffing boxes ought to receive that prompt attention which prevents further and more serious trouble. There is little doubt that the very important subject of steam piping is rapidly being taken out of the hands of the steam-fitter and placed in those of the engineer and the results should prove of material benefit to the safety and convenience of the power-plant.

The Port of Calcutta.

THE port of Calcutta is at present the subject of much discussion, improvements being necessary and the character and extent of them being a most difficult problem. Two articles relating to this subject contain much matter of interest, one being an address by Sir Charles Cecil Stevens before the Society of Arts, and the other an article in the *Indian and Eastern Engineer*, both showing the necessity for improvement in

the trade facilities of Calcutta if the city is to retain its commercial importance.

The address of Sir Charles Stevens contains much very interesting matter concerning the history of the city and its commerce, and shows how difficult the control of the Hooghly river always has been. Calcutta is situated about eighty miles from the mouth of the Hooghly, and for about forty miles from the city towards the mouth the river maintains a distinct limit, that is to say, as far as the point called Diamond Harbour, while the remainder of the distance constitutes the estuary, filled with shifting shoals, and tortuous channels to the sea. It is the upper portion, extending from Calcutta to Diamond Harbour, which now demands the attention of the Port Commissioners, since there have been frequent alarms caused by changes in the river bed in this section.

Several plans have been proposed to avoid the difficult navigation in this portion of the stream, some involving the construction of canals for a greater or lesser portion of the distance, others including the construction of embankment works which should control the current and compel it to scour its own path, while the direct and definite idea of using powerful dredges to cut and maintain an ample channel, is also being considered.

In addition to the necessity for improvements in the channel of the river the question of increased accommodations in the port demands attention. The want of docks is being increasingly felt and although various sites have been considered none have been found acceptable except that at Kidderpore, where since 1892 the dock has been open and in use. At first there was little disposition shown to use the dock, but by 1895 the income began to meet the expenses, although the interest and taxes had to be met by the port dues.

As the jetties became more and more crowded the Port Commissioners decided to permit their use for imports only, thus compelling the export merchandise to be handled at the dock, and now ships of all lines go to the dock and many people are wondering how they ever got along without it. The jetties have nominally lost the business which the dock has gained, but in fact the commerce of the port has increased

to such an extent that the receipts of the jetties are practically as great as before the dock was in use. With the increase in the coal trade demand has arisen for increased accommodation, so that the construction of a second dock has become a matter for serious consideration.

As a counterpart to these plans for the improvement of the port may be noted the efforts to secure increased railway facilities from the upper provinces and the coal fields of Bengal to Calcutta. That this is a feature well worthy of consideration is shown by the fact that the total traffic of the East Indian Railway has more than doubled between 1890 and 1897, and that more than 67 per cent. of the total increase is in coal, which now forms more than one-half the

total traffic. With the various railway extension schemes which are under discussion is involved the Central Railway and Hooghly bridge, and the principal difficulty which this project encounters is the fear of any further direct levy on the trade of the port. The welfare of the whole city is, however, included in all the transportation facilities, both by land and by water, and the importance of the interests involved should cause this mutual dependence to be realised.

When so many important engineering problems are being earnestly discussed some material results should certainly follow, and the work of the engineer will in any case be required to assist Calcutta to maintain her position as a trade center.

REVIEW ^{OF} THE CONTINENTAL PRESS

The Simplon Tunnel.

ONE year ago the first actual constructive work was begun upon the Simplon tunnel, the latest and greatest of the undertakings connecting Italy by all rail with Switzerland, and from an article by Baurath H. Claus in a recent issue of *Glaser's Annalen*, a very complete account of the origin and details of the undertaking are obtained.

Until now there has been no complete rail connection between western Switzerland and Italy, and to reach Milan it has been necessary to go around to Lucerne and so on through by the St. Gotthard route. The Jura-Simplon railway from Geneva around the lake and up the Rhone valley, ascends to Brieg, at an altitude of about 2,300 feet, while on the Italian side the railway from Milan stops at Domodossola, at an altitude of 900 feet. Between the two lies the famous Simplon Pass, the distance between the two towns being 41 miles, over an elevation of 6,590 feet above the sea. Connection is now made by diligence, but this occupies nearly all day, and is available for passengers only, hence the plan to connect the railways by extending the road on the Italian side as far as practicable, and then to pierce the mountain by a tunnel.

The advantage of such a railway connection will be seen when it is understood that the distance from Milan to Calais by the Mont Cenis is 680 miles, by the St. Gotthard 665 miles, and by the Simplon only 585 miles. The distance from Ostend to Milan by way of the St. Gotthard is 59 miles longer than by way of the Simplon.

Herr Claus gives a review of the various schemes which, since 1857, have been proposed to pierce the Simplon, some of the earlier plans having been made in view of possible financial assistance from France on account of the benefit which would accrue to French trade, but the present undertaking is wholly a Swiss one, the concession having been granted by the Swiss and Italian Governments to the Simplon Tunnel Company, which is practically controlled by the Simplon-Jura Railway.

The plans included the prolongation of the railway on the Italian side from Domodossola to Iselle, about 2,100 feet altitude, where the Italian entrance to the tunnel is made, and here the first work was started in August, 1898. On the Swiss side the entrance is at Brieg, and the tunnel will connect the two stations of Brieg and Iselle, being 64,735 feet, or 12.26 miles long. This is nearly 3 miles longer than the St. Gotthard tunnel, but the altitude is less, being only 2,300 feet above sea instead of 3,800 feet, as at St. Gotthard.

In plan the tunnel is to be straight, with a short curve outside of each entrance connecting with the approaches, the highest point being almost at the middle, with a grade of 1 in 143 on the Italian side and 1 in 500 on the Swiss side. The principal difference between the tunnel and those previously pierced through the Alps lies in the fact that instead of one single tunnel two tunnels are to be constructed side by side, running parallel to each other at a distance of 55 feet from centre to centre. This construction enables a double track railway to be carried through without involving the removal of so much rock as is necessary in the case of a single double-track tunnel, and constructively the plan possesses several advantages.

At first but one of the two tunnels is to be completed to the full dimensions, the other being carried through at only about one-fourth the area of the ultimate cross section, connecting passages being pierced every 650 feet to communicate with the other finished tunnel. The one complete tunnel will then be used as a single-track passage until the demands of the traffic shall render it advisable to complete the way for the second track, and in the meantime the smaller parallel passage will be used as a ventilating flue, fans being connected as may be found necessary. The second tunnel will also be used to drain the water from the first one, and thus the work of completing the full sized passage is expected to be greatly expedited. Both tun-

nels are now being bored by the use of the Brandt hydraulic rotary drills, water being supplied at a pressure of 70 to 100 atmospheres through two 4-inch pipes, there being twelve machines in all now in use, with a total consumption of about 40 cubic feet of water per minute at a pressure of 70 to 100 atmospheres. The borings are to be made through gneiss, micaceous limestone, and slate, holes $2\frac{3}{4}$ inches in diameter and 4 to 5 feet deep being bored and the rock brought down by the use of dynamite. A narrow gauge railway is employed to remove the débris, the smaller tunnel being used for the discharge and the track in the main tunnel for the return.

The entire work is mapped out in a programme, which contemplates the completion of the one main tunnel and the smaller auxiliary tunnel in five and a half years, the allotment for each year being increased as the facilities for the work are augmented. The work of the first year includes the erection of the extensive power plants and workshops at each entrance, and at the close of 1898 there had been completed about 300 feet of boring on the south side, and 1,300 feet on the north.

The cost of the work is divided into three parts as follows:

	Francs.
1. Preliminary work, including surveys, plant and track..	7,000,000
2. Boring one complete tunnel and the small auxiliary.....	47,000,000
3. Completing auxiliary tunnel..	15,000,000
Total for the complete double-track tunnel.....	69,000 000

If these figures are not exceeded the cost of the tunnel per metre will be 3,475 francs. Some comparisons with the costs of the other Alpine tunnels will be of interest in this connection. The Mont Cenis tunnel, the first to be built, cost 75,000,000 francs, or about 6,130 francs per metre, but this high cost was partly due to the protracted period over which the work extended, as well as to the absence of modern tunnelling machinery. The St. Gotthard tunnel cost 59,750,000 francs, or 3,984 francs per metre, so that the Simplon tunnel will cost very little more per metre than the St. Gotthard, notwithstanding the greater length. The above cost is for the tunnelling only and does not include the construction of the permanent way.

The Marseilles Canal.

IN former times the port of Marseilles profited very greatly by the traffic which passed from central and northern France eastward on the Mediterranean, but since the completion of continuous railway communication through the Alps much of this trade has passed on to Genoa, and Marseilles has suffered accordingly.

Before the opening of the Mont Cenis tunnel the eastern mails were sent from Marseilles, but this business is now transferred to Brindisi. The completion of the St. Gotthard tunnel has placed Genoa within 315 miles of Bâle, while the distance from Bâle to Marseilles by railway is more than 450 miles, hence nearly all the merchandise sent from England, Belgium, Holland and German Switzerland goes by rail to Genoa by way of Bâle. When the Simplon tunnel is completed the commercial importance of Genoa will be still further increased, and as nearly all of this traffic will be diverted from Marseilles the consequences to the latter port are most serious.

Various plans have been proposed to enable Marseilles to maintain her position in the face of this increasing competition. A railway from Chagny to Hirson has been discussed, and such a road would result in a gain of nearly 60 miles over the St. Gotthard route, but constructive difficulties have caused this plan to be given up.

The most probable solution of the problem lies in the development of cheap and convenient water transport connecting Marseilles with the region from which its traffic must be drawn, and in a recent issue of *La Revue Technique* the proposed canal from Marseilles to the navigable waters of the Rhone and its tributaries and connections is discussed and its capabilities set forth.

The Rhone, with its canal connections with the Seine, the Loire, and the Rhine, affords a general access to the interior of western Europe, but the shifting sand bars and obstructions at its delta render navigation difficult at the mouth. For this reason a short canal has been made from St. Louis to the Gulf of Fos, giving access from the Mediterranean to the navigable channel of the Rhone for vessels of not more than 18 feet draught. This canal, however, does not admit of direct delivery to the port of

Marseilles, and hence the plans have been made for a complete waterway from Marseilles to the Rhone at Bras Mort, a distance of 34 miles.

The construction of the canal, as shown in the various sections, is of interest. On leaving Marseilles it will skirt along the shore of the bay of Madrague, the channel being formed by a dike and breakwater separating the water of the bay from the channel. It then makes a sudden turn and pierces the mountain which separates Marseilles from the lake called Etang de Berre, a tunnel $4\frac{1}{2}$ miles long being necessary. The channel will then be carried around the side of the lake, and then pass through to the Gulf of Fos, an open cutting only being necessary in this case, and from thence in a straight line it proceeds to Bras Mort on the Rhone, at a point where there is a depth of 20 feet of water, and from which steamboats of 1,000 tons displacement can reach a country within a radius of more than 300 miles. In this way access will be given from Marseilles by the Rhone to Lyons, and by the Saone to Chalons, while through the existing system of internal waterways boats of 300 tons can reach Nancy, Paris, Havre and Lille.

Since the cost by water transport, especially for heavy merchandise, is only about one-half what it is by rail, the completion of this important water-way, with its connections, should restore in large part the merchandise traffic which has been taken from Marseilles by the railways. This is especially true of bulky merchandise, in which the expense of transport forms a large proportion of the total cost, and it may be expected that for the transport of coal, minerals, metallurgical products, fertilisers, cereals, wines, etc., the water-way will command the traffic. The construction of the canal may therefore be said to interest not only the port of Marseilles, but also the whole of France, since the influence which this cheap outlet will have upon French products must be stimulating.

The total cost of the canal is estimated at 80,000,000 francs, of which one-half is provided by the local interests, including the Department des Bouches du Rhone, the municipality of Marseilles, and the Chamber of Commerce, and the work is expected to be completed in ten years.

The Sterilisation of Potable Water.

ALTHOUGH it has been known for some time that water could be sterilised by contact with ozone, the data concerning the working of the process on a large scale have not hitherto been available. We now have, however, a report of a commission appointed by the municipality of Lille upon the practical operation of the process as there installed by MM. Marmier and Abraham, and from a communication by the latter to the French Academy some details are here abstracted.

The apparatus used at Lille may be divided into three parts, the electrical generator, the generator of the ozone, and the sterilising apparatus proper.

The electrical apparatus offers no features of especial interest, except that the primary current is raised by a suitable transformer to a pressure of 30,000 volts. The ozone generator utilises this current to produce sparks between suitable electrodes, the electrodes being cooled by a separate internal circulation of water, this cooling of the electrodes being considered as quite an important feature in the production of ozone on a commercial scale.

On leaving the generators the ozone enters a masonry tower, where it meets the water to be sterilised, the circulation being controlled so that an intimate and thorough contact is assured.

The water has been previously filtered, so as to remove all solid impurities, and the contact with the ozone is intended to destroy the bacteria which may be in it.

After the installation at Lille had been in use for several months a commission of experts, consisting of such notable specialists as Dr. Roux, of the Pasteur Institute at Paris; Professor Buisine, of the Faculty of Sciences at Lille; Dr. Calmette, of the Pasteur Institute at Lille, and Professor Bouvriez, was appointed to make a report upon the working of the plant.

Only the conclusions of the report are given, from which the following is obtained:

All pathogenic or saprophytic microbes which were found in the unsterilised water were entirely destroyed by the passage of the water through the ozonising tower. The only germs which resisted this action were a few of the kind known as *Bacillus*

subtilis, this being the microbe which is found in hay, and being entirely harmless either to man or to animals. It is interesting to note that this microbe also resists the action of steam at a temperature of 110° C.

The ozonisation of the water introduces no element whatever which can be injurious to the health of those using it; on the contrary, since there is no increase in the nitrates and a considerable decrease in the quantity of organic matter present, water which has been subject to the ozone treatment is much less liable to subsequent pollution.

It is unfortunate that nothing is said in this communication about the cost of the sterilisation of water by this process, and it is to be hoped that data as to the number of cubic metres which can be sterilised by a kilowatt of electrical energy may be obtained from this important installation. In many cases power is available where pure water is not to be had, and the introduction of electrical sterilisation becomes a question of cost alone. In connection with hospital service also the importance of obtaining a reliable supply of sterilised water can readily be appreciated.

In this connection it may be mentioned that M. E. Andreoli, in a communication to *L'Electricien*, calls attention to the fact that the use of electrodes cooled by water circulation in the production of ozone is his invention, and shows that he used this method before 1896.

Steam Engines for Rolling Mills.

AMONG the papers read before the recent convention of the *Verein Deutscher Eisenlüttenleute*, at Düsseldorf, was one by Herr C. Kiesselbach upon the subject of engines for rolling mill service, which contained an excellent review of the requirements of this exacting branch of work.

Before discussing the general details of rolling-mill engines, Herr Kiesselbach showed the great advantages which compound engines offer for this service. Owing to the variable nature of the load the point of cut-off must vary very greatly in single cylinder engines, and as steam is often carried full stroke the loss from clearance and internal condensation is often large, while if condensing engines are used the sudden discharges of high-pressure steam when

working under heavy loads renders it difficult to maintain a satisfactory vacuum. For these reasons compound engines are greatly to be preferred for rolling-mill use, a wide range of power being available, while at the same time good economy is obtained. It is true that compound engines have not showed so high a steam economy in rolling mill service as has been obtained in spinning mills and other factories where the load is practically constant, but this is not to be expected, and a more just comparison is had by observing the performance as compared with single-cylinder engines in rolling mills.

In order that an ample reserve power may be had for emergencies it is advisable to use a somewhat smaller cylinder ratio than would otherwise be adopted, and good practice varies between the ratios of 1 : 2 and 1 : 2.3; and the cut-off in the low-pressure cylinder should not be set too early or the pressure in the receiver may occasionally back up too high. Triple-expansion engines are not so well adapted as compound engines for rolling-mill use, since the sudden changes of load occur too rapidly for a change in regulation to affect all three cylinders in time, as is plainly shown in indicator diagrams.

The cross-compound engine with cranks at 90° has almost disappeared from German rolling mills, preference being given to the tandem compound. The general arrangement is as follows: The high-pressure cylinder is placed in front, or nearest to the crank, and the forward cylinder head is either cast in, or arranged so that the joint can be packed without taking down the engine. The two cylinders are connected by a trunk of such a section that its center of gravity coincides with the axis of the piston rods. The front head of the low-pressure cylinder is arranged so that it can be inserted from the rear end of the cylinder, and the bore and flanges are so proportioned that the rear head of the high-pressure cylinder can be drawn out through the low-pressure cylinder. By removing the rear head of the low-pressure cylinder, and disconnecting the piston rod from the cross head, both pistons and heads may be withdrawn together with the rod. This operation is facilitated in the case of large engines by

having an opening in the upper part of the connecting trunk, so that supporting chains from an overhead crane may reach the rod. No guide is necessary between the two cylinders if the pistons are not made too heavy and are provided with sufficient bearing surface.

Most of the tandem compound engines are built with fly wheels, but a similar construction is adopted for reversing engines, and notwithstanding the higher steam consumption the latter style is coming more into general use.

Herr Kiesselbach's paper is accompanied with numerous plates, showing very fully the construction adopted by several of the leading engine builders of Germany, while details of bearings, pistons, packings, and other parts are fully given.

The advantages of superheated steam are discussed, and a superheating of 80° to 100° C. above the temperature of saturated steam is said to require no especial modification in the engines in which it is to be used. When, however, a high degree of superheating is employed by which is meant an elevation of temperature to about 350° C., it is necessary to provide for the action of such steam upon the joints and packing. Special designs of stuffing boxes for such superheated steam are shown, and emphasis is placed upon the necessity of arranging the working parts so that the temperature may be maintained as nearly uniform as possible in the various portions, in order that distortion from unequal expansion may be avoided.

Balanced slide valves, piston valves, and poppet valves are all used in the various designs, and especial care must be given to the stop valve, this latter being so arranged in some cases that it may be adjusted either gradually by hand or closed or opened promptly by power, and in every case the arrangement of handles and controlling levers is a subject requiring much care and judgment. The operator of a rolling mill engine must have his machine at all times under the most complete and prompt control, and this forms an important feature in all the designs.

The whole paper of Herr Kiesselbach, with the animated discussion which it elicited, forms an important contribution to the record of present rolling-mill practice in

Germany, and as such is worthy of careful examination.

It is interesting also to note that in the course of the discussion it was mentioned that electricity is also being employed for this service, a 500 horse power electric motor being successfully used in rolling wire rod of 6 mm. diameter, and it is not impossible that electricity may become widely adopted for driving rolling mills.

Progress in the Use of Blast Furnace Gases.

At the meeting of the *Verein deutscher Eisenhüttenleute* last year a paper was read by the well-known metallurgical engineer, Herr Fritz Lürmann, upon the use of blast furnace gases for motive power when used direct in gas engines. At that time he expressed himself rather unfavorably, basing his criticisms mainly upon the injurious effect which the dust in the gases might produce in the cylinders, besides urging other objections.

In a second paper, presented at the recent meeting of the same society at Düsseldorf, Herr Lürmann discussed the progress which has been made in the application of furnace gases to motive power, and shows that most, if not all, of his former objections have been modified or removed during the interval which has elapsed.

The principal bugbear, the dust, seems to have been found amenable to control, notwithstanding the difficulties which appeared at first. The dust which is discharged with the gases from a blast furnace comes both from the ore and the fuel, and may be divided into three kinds. The first portion is the coarse granular dirt, which is so heavy that it is deposited in the first passage after leaving the furnace or in the dry purifiers, and does not reach the engine at all; the second portion is much finer, but with care can be removed by wet scrubbers before the engine is reached; the third portion is a very fine, impalpable powder or soot, partially thrown down during the combustion of the gas, and not removable by any preliminary process. This finest dust, therefore, must be expected to appear in the cylinder, and, although it is not of a nature to cut the surfaces, it forms a thick mass with the lubricant, especially at the

high temperatures at which the latter is already beginning to be carbonised. Notwithstanding the fact that this dust is deposited in the cylinder, practical experience has shown that no serious results follow, and the engines which have been operated with furnace gases during the past year have experienced no serious trouble from clogging in the cylinders.

Taking the performance of several engines of which complete tests have been made public, it appears that the use of blast furnace gases for motive power in gas engines is entirely practicable from a mechanical standpoint, and hence Herr Lürmann proceeds to discuss the subject from an economic point of view. To this end he undertakes to answer the two questions: How much power can be obtained from the gases produced in the reduction of a given quantity of iron; and, How much money is to be saved?

At the present time these questions can only be answered upon theoretical grounds, but the conclusions thus reached may be checked by the limited number of observations available, and the probable percentage of the theoretical gain which may be expected can be determined.

In the production of a ton of pig iron there are generated 165,000 cubic feet of gas, of about 100 B. T. U. thermal value per cubic foot. Of this about 28 per cent. is required for the heating of the blast, while about 10 per cent. may be estimated as lost by leakage and escape. The remainder may be used in any one of three ways: all may be burned under steam boilers; a portion may be used under boilers and a portion in gas engines; or, all may be used in gas engines. In the first case about 40 per cent. will be required to produce the power required by the furnace, leaving 22 per cent. available for other purposes; in the second case the same is true; while in the third case only about 11 per cent. is required for the furnace power, leaving more than 50 per cent. available for profit. The principal difference between the first and second cases lies in the fact that in the one only about $3\frac{1}{2}$ h. p. per ton can be produced, while in the other, $12\frac{1}{2}$ h. p. is obtained. This is due to the fact that the gas engine is so much more economical than the steam engine.

The production of pig iron in Germany during 1898 averaged 20,280 tons per day, and Herr Lürmann computes that if all the excess gas were burned under steam boilers, about 70,000 h. p. would be generated, while if utilised in gas engines the available power would be 253,500 h. p., and if the total of the discharge gases were thus converted into power the amount would be about 570,000 h. p. This last supposition involves the substitution of gas engines for steam as motive power at the furnaces, and includes the successful design of gas-power blowing engines, but there is no reason to assume that this problem may not readily be solved.

The value of the introduction of the last named use of the gases is stated by Herr Lürmann as follows:

Taking the gain of power as 500,000 h. p. per day of 24 hours, or 4,380,000,000 h. p. hours for the year's iron product of Germany, and assuming that one h. p. hour could have been produced by one kilogramme of coal, the fuel value of this power is 4,380,000 metric tons, and taking coal at 10 marks per ton, we have a profit of nearly 6 marks per ton of iron, or allowing 50 per cent. for losses and attendance there might be a money value of 3 marks for every ton of iron produced, a value which is now thrown away.

In all his computations Herr Lürmann has rather erred on the side of conservatism, and the details of his figures are given in full, so that in this important paper we have a full, critical analysis of this question given by one who began his investigation with rather a prejudice against the practicability of the idea. Under these circumstances it certainly appears as if the saving of the vast amount of power at present wasted cannot be deferred, not only in Germany, but everywhere where iron is produced and power utilised.

The Ventilation of the St. Gotthard Tunnel.

FROM its first operation the St. Gotthard tunnel has been noted for its excellent natural ventilation and freedom from smoke, being in this respect a notable improvement over the Mont Cenis tunnel.

The increase in traffic, however, has led to the operation of a much greater number of trains than formerly, and hence the

natural current of air has been found insufficient to keep the tunnel free from smoke. The increase will be seen from the statement that in 1888, 32 trains passed through the tunnel in 24 hours, while in 1897 the number of trains reached 61, practically double.

In a recent issue of the *Schweizerische Bauzeitung* the discussion about the ventilation of the tunnel is given at some length, together with an illustrated account of the new plant which has been installed at Göschenen, at the northern portal, where a ventilating plant on the Saccardo system has been erected.

Before attempting artificial ventilation it was suggested that compressed air, or electricity be employed as a motive power in hauling trains through the tunnel, and before resorting to such a radical change experiments were made with smoke burning devices and with smokeless fuels. It was finally decided, however, to assist the natural current, which grows sluggish when the pressure on the northern side becomes nearly equal to that on the lower, by providing a pressure blower system to maintain the air current from north to south.

The general arrangement of the ventilating plant is simple. A power-house containing the motive power and two large pressure blowers, was constructed near the north portal, and air conduits led to a chamber just within the entrance. Here two annular passages were constructed, each reaching half way around the periphery of the tunnel, the passage above being connected with one fan, and that below with the other, and both opening into the tunnel itself. The two fans, each of which is 5 metres in diameter, are mounted on the same shaft, with a grooved pulley between, and in the preliminary experiments they have been driven by a locomotive, the axle of the engine being coupled to a second shaft carrying a grooved pulley, and rope transmission being used to the fan-shaft. When the plant has been in service long enough for sufficient experience to be had as to speeds, capacities, etc., it will probably be driven by transmission from some convenient source of water-power.

The principal feature of the Saccardo system lies in the surrounding of the tunnel

passage with an annular ring delivering air into the entire periphery, thus preventing the formation of lateral currents, and at the same time inducing a suction of air into the mouth of the tunnel. Experience with the system in the Pracchia tunnel through the Apennines, on the Bologna-Pistoia line, has been satisfactory, and from the brief trials which have been had at Göschenen it is believed that there will be no difficulty in maintaining a current of 3 metres per second from north to south regardless of atmospheric conditions.

Refuse Destruction in Berlin.

EVER since it has been shown that a commercially valuable amount of power can be obtained from the burning of municipal refuse, attention has been directed towards possible improvements in refuse destructors and their attached steam plants.

A recent issue of the *Gesundheits-Ingenieur* contains a review of the performance of the new Wegener destructors now in operation in Berlin, and the experience which has been gained in the operation of this plant is of material value for future information. The important feature in every successful refuse destructor is the production of a high temperature within concentrated limits, since the difficulty with which some portions of the refuse ignite causes the combustion otherwise to be very imperfect. For sanitary reasons alone it is important that every particle of organic matter be consumed and reduced to an inorganic state, while naturally the highest thermal efficiency can only be reached with complete combustion.

The Wegener furnace aims to accomplish this result by the use of pulverised fuel instead of firing with coal or coke. When solid fuel is used it is found necessary to use an air-blast in order that the necessary temperature of 1,600°—1,800° C. be reached, and, unless some form of regenerative system be used to heat the air, this method involves intermittent cooling during the intervals of firing, while it is of the utmost importance that a constant and practically uniform high temperature be maintained if successful results are to be secured. By the use of pulverised fuel, introduced continuously with the air blast,

no interruption occurs either in the supply of fuel or air.

The principal criticism which has been made of the Wegener system of firing, when applied to ordinary boiler furnaces, is the cost of pulverising the coal, but when, as in the present plant, a double duty can be obtained, this point becomes a secondary consideration.

When the system of firing a destructor with pulverised fuel is employed, a temperature of about $1,400^{\circ}$ C. is produced in the discharge gases after they have acted upon the refuse, and this is a higher temperature than is usually experienced in the flues of a boiler furnace. This is partly due to the fact that in the Wegener furnace the air blast is heated by passing through a flue at the base of the chimney, and also to the additional heat produced by the burning of the combustible portions of the refuse.

When such a high temperature as that obtained by firing with powdered fuel is secured there is found to be no necessity for sorting the refuse, since everything is either burned to gas or else fused into slag, all being rendered innocuous and much more available as fuel.

The Berlin destructors are masonry structures each formed in three stages, one above the other. The upper portion contains the charging chambers, into which the refuse and powdered fuel are dumped, being raised to the top by electrically-

driven conveyors. In this stage the fuel and refuse are separated from each other by a partition wall. From this stage the materials fall through hoppers into the second portion, where a sort of dry distillation takes place, the heat being supplied by flues through which the discharge gases from the furnace pass; these chambers are formed of large sheet metal cones which slowly revolve, and make a thorough drying possible without clogging. From these cones the refuse and fuel fall into the lower, or combustion chamber, where they meet a powerful hot-blast of air, and where the burning of the powdered fuel produces an intense heat, everything combustible being completely burned, while the non-combustible matter is fused to a liquid slag, which collects on the bottom of the chamber, and can be drawn off, and cooled to a brittle, glassy cinder.

The completeness of the combustion is shown by the fact that no smoke appears at the chimney, although the gases are cooled by having the greater portion of their heat abstracted from them by being passed through the boilers of the attached steam plant.

According to the *Gesundheits-Ingenieur* the plant is very satisfactory as a sanitary method of disposing of the refuse, and although detailed trials are not yet made public, it is believed that the efficiency of the steam plant makes it also a commercial success.

REVIEW OF THE AMERICAN PRESS

The American Society of Civil Engineers.

At the recent convention of the American Society of Civil Engineers a number of important topics were presented and discussed. The address of the President, Mr. Desmond Fitzgerald, dealt mainly with the historical side of civil engineering in America, and contained some very interesting information about early engineering works and the men who constructed them.

Almost immediately after the close of the Revolutionary war, engineering works were contemplated and undertaken, but it was then deemed necessary to send to Europe for trained engineers. The first important work was the Potomac canal with its locks around the Great Falls, a work in which Washington was interested. The work on the Santee canal, in South Carolina, was under the superintendence of Colonel Christian Senf, a Swedish engineer, while the early works of the Schuylkill and Susquehanna Navigation were under the charge of an English engineer, William Weston. Weston also supervised the canals which were constructed in the Mohawk and Hudson valleys, and ran the levels for the Middlesex canal, in New England, and the first great engineering work which was executed solely by American engineers was the Erie canal, Geddes, Wright, Brodhead, and their assistants carrying the great work through to success between 1817 and 1825. From this time onward most of the engineering work in the United States was done by Americans, experience and opportunity producing the many able men whose names are given by Mr. Fitzgerald. The early work was mainly canal construction, followed by bridge construction, docks, and later by railroading.

All this relates to civil engineering pure and simple, for in mechanical engineering the names of Oliver Evans, John Stevens, and Robert Fulton antedate those of the pioneers in the allied branch. Mr. Fitzgerald's address contained much matter of more than mere historical interest, and is a most worthy record of the work of the

predecessors of the modern leaders of the profession, all of whom are proud to render honor to the founders of civil engineering in America.

Of the discussions and papers presented at the convention only the most important features can be here noted. The questions involved in the assumption of loading in connection with bridge design brought out a very sensible line of thought, *i. e.*, the desirability of arriving at the real conditions, even if this can be done only approximately, rather than to make refined calculations of precise appearance but of doubtful accuracy. When such competent speakers as Gustav Lindenthal and George S. Morison attack the subject of false refinements, and go straight to the actual conditions which obtain in practice, some very definite conclusions may be expected. One point especially made by Mr. Morison is worthy of note, namely, that the type of engine which is used in testing a bridge becomes obsolete long before the bridge is worn out, and in fact a bridge should always be planned for future requirements rather than for present use.

The question of the contamination of streams by sewage was brought up in an effective manner by a protest from St. Louis engineers against the discharge of the drainage of the Chicago canal into the Mississippi, and there seems to be little doubt that this matter will demand a solution of some sort before very long. As the subject now stands there is no legislation against the pollution of streams, and it is believed that some action by the society would have weight with Congress, as this is a matter in which federal action is necessary. Methods of sewage purification were discussed, but so long as it is possible to pass the wastes on to some other locality it will be difficult to introduce any such plants.

Another prominent discussion was that upon the question of the applicability of electricity to main-line railways, and it is rather interesting to notice how the views of the various speakers indicated their pres-

ent affiliations. It is very difficult for any railroad man to see anything good in electric propulsion for anything but local and suburban traffic, and the possibility of railway traffic ever becoming modified because of the use of electricity is something which the orthodox railroad engineer does not want to think about. Colonel Haines showed that electricity was more suitable for light, frequent trains than for heavier ones running less often, but no one seemed to see in that an argument for running light, frequent trains altogether, obvious as the suggestion might appear. The fact that the fuel-saving of power houses over locomotives is not great was brought out strongly in opposition to the use of electricity, but the absence of reciprocating parts, and the advantages of independent motor cars were features altogether too radical for the average railroad man to accept. It must not be forgotten that the traffic conditions, which are assumed to control the subject, are themselves the creation of the present railroad system, and that a new system may create new traffic conditions adapted to its capabilities, and none the less effective because they happen to be different from those which now exist.

No one doubts that if aerial navigation should become a practicability an entirely new set of traffic conditions would instantly be created, and the old conditions would be altogether powerless under such circumstances. When the mechanical conditions which are necessary to adapt electric traction to main line service are fulfilled the traffic conditions may be found equally powerless.

An important paper was presented by Colonel Raymond upon breakwater construction, with especial reference to the Delaware breakwater, recently completed, and of which a detailed account was given.

Coal-Cutting Machinery.

THE substitution of machinery for manual labor in the cutting of coal is a noteworthy example of the work of the engineer in a field where it was most needed, and the history of the invention and introduction of these machines forms the subject of an important paper, presented, with the permission of the Director of the United States Geological Survey, before

the American Institute of Mining Engineers by Mr. Edward W. Parker.

The earliest patent for an under-cutting machine was issued to Simkins in 1858, since which time no fewer than 468 patents have been issued. Mr. Parker, however, wisely limits himself to a discussion of those machines which have survived the test of practice and have shown by actual use the success of applying mechanical methods to the mining of bituminous coal.

The machines used for cutting bituminous coal may be divided into three main classes: Pick machines, shearing machines and chain machines; these latter also including long-wall machines.

The pick, or punch, machines consist practically of a horizontal cylinder, the piston-rod of which terminates in a chisel-like cutting tool which punches its way into the coal when a reciprocating action is given, compressed air being the motive power. The machine is placed upon an inclined platform, and traverses along the face of the coal as close to the floor as possible, the tool cutting a channel under the mass in such a manner as to leave it in good shape for blasting and loading.

Since 1894 the pick machine has had to contend with the chain under-cutting machine, this operating upon an entirely different principle. In this form of machine the work is done by cutters attached to the links of an endless chain, the action being of a planing nature instead of punching.

"In the attack upon the coal the cutting parts operate at right angles to those of the cutter-bar. The chain, with its cutting-bits, is driven, either by compressed air or electricity, as the case may be, at a speed of from 250 to 275 feet per minute, and the movable frame, carrying the chain and the motor, is fed forward at a speed determined by the resistance offered by the coal. The rear end of the machine is securely held in place by means of a jack, set to the roof, while the forward end is secured by a jack set at an angle of about 45° into the face of the coal. The forward jack is placed at this angle in order to overcome the tendency of the machine to be forced sideways as the chain cuts the coal.

"One of the most notable, and, so far, practically the final step in the development of a successful mining machine was

made when the chain machines were brought out. The speed with which one of these machines will do its work seems almost incredible. An average of five minutes, after the machine is in position, is required to make a cut 6 feet deep, 44 inches wide and $4\frac{1}{2}$ or 5 inches high, and to withdraw the cutting-frame, is the ordinary measure of the effectiveness of this type. A record of 1,700 square feet of cutting in nine and a half hours is claimed for one of these machines. This would mean about seven and a half minutes to each cut 6 feet deep and 44 inches wide, including the moving and setting of the machine."

Shearing machines are made to operate also with the endless chain, the cutting being done in a vertical instead of a horizontal plane. The long-wall machines, although on the same fundamental principle as the chain machines do not require the chain, as the less depth of cut renders it possible to mount the cutters on a revolving horizontal disk, but otherwise the general arrangement of the mechanism is the same as in the chain machines.

The introduction of these various kinds of coal-cutting machines has had much to do with the great increase in the amount of coal mined during the past few years, and this again has been a potent factor in the reduction in the cost of coal to consumers, the average price of coal at the mines having declined from \$1.12 in 1887 to 81 cents in 1897. The number of machines in use has increased from 545 in 1891 to 1,446 in 1897, the tonnage mined by machinery in the United States having increased from 6,211,732 to 22,649,220 during the same period.

The Testing Tank at Washington.

THE completion of the new government testing tank at the Washington Navy Yard has been the occasion of the publication of some excellent accounts of this important adjunct to the Construction Bureau, and interest has been added to this work by the liberal manner in which opportunity was given to the members of the American Society of Mechanical Engineers to inspect the tank, and to have its construction and operation explained. From the various accounts which have been published we may refer to one in *Engineering News* as

being from the pen of Naval Constructor D. W. Taylor, whose experience in the construction and operation of the apparatus renders him especially qualified in this respect.

The early experiments of Froude, in 1870, although made with a small tank, demonstrated the importance and value of the method of studying hull designs by experiments with models. Since Mr. Froude's death his work has been continued by his son at the larger tank built by the British government at Haslar, near Portsmouth, and tanks have been built by the Italian and Russian governments as well as by the private firm of Messrs. Denny, at Glasgow.

The Washington basin has been constructed from an appropriation of \$100,000 made about two years ago, but the completion of the work was somewhat delayed by the war with Spain, so that the entire apparatus is only now ready for service. It is contained in a special building 500 by 50 feet, the tank being 43 feet wide, 14 feet 8 inches deep in the centre, and 470 feet long. The carriage, by which the model is towed and upon which the recording instruments are mounted, is really a form of electric traveling crane spanning the width of the tank and running upon rails along each side. A lever projects down to the water and is attached to the model to be tested, and the resistance is measured and recorded upon a revolving drum by means of an ingenious spring dynamometer. The speed of the carriage can be varied from 1-10 knot to 20 knots; that is from about 10 feet per minute to 2,000 feet, and the weight of the towing bridge and platform, about 25 tons, acts as a sort of fly-wheel to steady the motion and assist in maintaining a uniform and the recording apparatus, the Washington rate.

The recording apparatus consists of a drum upon which time and distance are recorded in connection with the record of the pen connected with the dynamometer, while a set of pens connected with weighted springs draw at the same time a set of reference lines from which the record of the dynamometer pen can be measured.

Apart from the completeness of the tank and the recording apparatus, the Washington tank is noteworthy because of the greater size of the models upon which the

tests are made. The foreign tanks are made for use with models from 10 to 12 feet long, while at Washington the models are 20 feet long, an increase of nearly five times the displacement over a 12-foot model, with a corresponding increase in the reliability of the results. Special attention is also given to the purity of the water and to the uniformity in temperature, a system of warming pipes being arranged for use when the external temperature requires it.

In the European tanks the models have always been made of paraffine, but at Washington it has been thought advisable to use wood, both on account of the warm weather in which much of the work will have to be done and also because of the larger size of the models. The use of wood requires some ingenious tools for the rapid reproduction of the lines of the vessel under test, and the model building shop forms a most interesting adjunct to the tank.

From the drawings of the proposed vessel a number of cross-sections are made, enlargements from the drawing size to that required from the 20-foot model being made by the aid of a pantograph, and upon these cross-sections thin battens are nailed, a model thus being formed. This pattern is then placed in a copying machine constructed on the principle of the Blanchard lathe, and a heavy wooden model for use in the tank is reproduced. The model is carefully measured in order to confirm the accuracy of the work, and is varnished to prevent the water from injuring it, and in this way an accurate reproduction of any hull design which may be submitted can be rapidly obtained. This is the more important because the law authorizing the construction of the tank also authorized experiments to be made for private shipbuilders at the actual cost of the test, providing such work did not interfere with naval tests. With such complete appliances for reproducing the lines of any design which may be sent in, and in view of the fact that the tests for private builders are made at cost, the trial tank should prove an important factor in the improvement of hulls and in the powering of vessels for the navy.

At the present time the staff attached to the trial basin is engaged in making experiments to determine the frictional co-

efficients needed in connection with the computations upon the tests, and as soon as the preliminary lines of the new cruisers are completed experiments will be made upon them to determine what modifications, if any, are needed.

The Design of Electric Vehicles.

THE increasing use of automobile vehicles and the evident important position which they are destined to occupy in the course of a short time renders some comments upon the designs which have thus far been made public appropriate at the present.

The recent exhibition of electric vehicles at the Electrical Exposition in New York was probably the most complete collection of automobiles which has yet been made in the United States, and from an article in the *American Machinist* describing these vehicles, and especially devoted to the Riker electric wagon, some points relating to the general features of design may be made.

"In spite of the troubles with the tire, due to the great battery weight, there are certain large and highly important fields of automobile effort to which the electric wagon seems better adapted than any other horseless vehicle, and in which these silent, clean, docile and elegant carriages will probably long preserve their supremacy.

"The two principal fields for use for the electric carriage are private carriages for wealthy city dwellers, and the delivery of purchases from the large stores to their customers."

While electricity seems to be in every way the preferable motor for vehicles which are to make short runs on paved city streets, it has not yet manifested its superiority for public cabs, for which the conditions are different, the range of work in this case becoming so great that the storage battery becomes a grievous burden, both to the propelling power and the wheel tires.

An interesting feature about these electric vehicles, however, is the incongruity between the two different portions of the construction, as represented by the work of the engineer and the carriage builder respectively. The railway carriages in Europe still bear the evidence of their origin in imitation of the stage coaches which pre-

cided them, and even where the form of the stage coach body is not retained there are curved external moldings, or perhaps only stripings of paint to give evidence of the evolution, much as the thickened cartilage on the human ear shows where the pointed tip of the simian ancestor once existed.

There is, unfortunately, every evidence that a like absurdity may prevail in the case of the design of motor vehicles. When the designer is concerned with purely mechanical or electrical problems he shows a singular freedom from the influence of precedent, and as the article above mentioned demonstrates the mechanical details are worked out with an ingenuity and skill which can only appear when the end to be accomplished is studied in direct connection with the means, and altogether independently of any hampering prejudices. It is engineer's work well done, in a thoroughly workmanlike manner. But, the engineer's work appears to cease when the motive power and its mechanism is completed, just as the work of the engineer, in Europe, at least, ceased with the running gear of the railway carriage, and the completion of the vehicle is left to the conservatism, prejudice and convenience of the carriage builder, who has proved himself altogether unequal to the task which should have been his greatest opportunity. Instead of attacking the problem directly and definitely, as there was every opportunity for him to do, he calmly went ahead and placed upon the self-propelling mechanism, so ingeniously designed for him by the engineer, the orthodox carriage-body, evolved from centuries of precedent of a totally different character.

A fair comparison of the proceeding would be found if the modern bicycle had been designed complete as to framework and driving gear and then sent to the harnessmaker and equipped with an exact counterpart of the saddle designed for use with the horse. The modern carriage bears every evidence of its evolution as a horse-drawn vehicle, and the advantages and possibilities in design which the absence of the horse permits appear as yet to be scarcely realized. The horse was in the way of a front entrance to the vehicle, so the user

was compelled to climb in over the wheels at the side. Now that the horse is no longer there the carriage builder still requires the rider to climb over the wheels, between the mud-guards of horsey days, and to an elevation which the height of the horse's body formerly made necessary, while the dashboard, which was naturally required to keep the heels of the equine from throwing mud over the riders, bravely retains its place as an example of the survival of the unfit. Heavy upholstery, enameled leather, freakish outlines and all the inheritance of the harnessmaker's influence, appear in the design, or lack of design, of the body of most of the current automobiles, and the machines have a mongrel appearance which shows their mongrel origin.

We say most automobiles, for there are some creditable exceptions, but these rare cases are those in which the engineer has ignored the carriage builder *in toto*. Makers of horse-drawn vehicles ought not to be slow to perceive that the rapidly approaching automobile is destined to work a great change in their industry. If the horse is to go, his form of carriage must go with him, and if the carriage builder is to save anything from the wreck he must make haste to adapt his product to the new conditions before he finds his trade has departed to join that of the builder of the old-time stage coach.

The Isthmian Canal Commission.

THERE was manifest disappointment expressed in various quarters when it was learned that the commission to be appointed by the President in accordance with the act of Congress to investigate and report upon the most feasible and practical route across the Isthmus of Panama for a canal was to be composed of practically the same members as constituted the old commission. This whole subject is very fully discussed in a recent issue of *Engineering News*, from which some significant extracts may be made:

"The fact that the majority of the commission comprises five such able engineers as Messrs. Noble, Burr, Morison, Hains and Ernst is one on which the engineering profession and the nation is to be heartily congratulated. The appointment of Alfred Noble is especially worthy of commenda-

tion. There is probably no American engineer better fitted by talent, experience and reputation to undertake the responsibilities which will be placed upon this commission than Mr. Noble, and engineers throughout the country will recognize his appointment as one conspicuously appropriate."

Of the others, Messrs. Burr and Morisor have made their reputations through their achievements as structural engineers, and have not had extended experience as hydraulic engineers, but at the same time their acknowledged eminence and broad ability should render them valuable members. Generals Ernst and Hains are both competent men, the former possessed of much experience on the Missouri and Mississippi River Commissions and the latter especially familiar with the Nicaragua problem.

Ex-Senator Pasco and Professor Emory R. Johnson are presumably placed upon the commission to look after the commercial and economic aspects of the problem, which form so large a feature of the subject.

The new commission will start on its work under much more favorable auspices than either of the two commissions which have preceded it, since both the Ludlow and the Walker commissions were limited in their scope to the investigation of the route of the Maritime Canal Company of Nicaragua. The adverse report of the Ludlow Commission, and modifications recommended by the Walker Commission have not strengthened the position of this company before the public, and as its charter will have expired before the next Congress assembles, this limited range of inquiry is not a matter of especial importance at the present time.

This feature being eliminated, the new commission will start on its work under favorable auspices. "The public sentiment in favor of Government construction, and against subsidies to or alliances with any private corporation, has now been made so evident that there will probably be little attempt to influence the action of the commission. Enough preliminary work has been done on all the proposed routes to greatly facilitate the commission's work and enable it to make a much broader

study of the question than has been possible at any previous time. The public will await with interest the final conclusions."

American Locomotives for Foreign Railways.

THE development of the American locomotive-building industry is one which can only be appreciated by people of other countries when it invades either their own territory or their own markets. The extent to which foreign demands are being supplied by American builders is not always appreciated, and a recent article in *Engineering News* gives some information on this point which is worthy of extended notice.

The export of American locomotives is by no means a recent matter; on the contrary, American engines were sent abroad three-score years ago. The first English order for American engines was in 1840, when locomotives built by William Norris, of Philadelphia, were used on the Lickey incline of the Birmingham and Gloucester Railway, now a part of the Midland system, where they competed successfully with the Bury locomotives in local service. It was Joseph Harrison, Jr., of Philadelphia, also, who, trained in the Norris works, secured the contract for the equipment of the St. Petersburg and Moscow Railway and built for that road in Russia many engines of American design in the early forties. Baldwin engines were also sent abroad about the same time, but the home demand which followed absorbed the energies of American builders for a time, and it was not until after the war that any material exports took place. Since, then, however, many foreign orders have been filled and during the past 24 years about 3,940 locomotives have been built in the United States for export, representing a value of more than \$36,000,000. For a time the foreign work represented but a small proportion of the total production, being in 1890 only about 7 per cent. of the entire number, but this has steadily increased, until in 1898 more than 30 per cent. of the total output of locomotives was for foreign account, these going to more than 30 different countries. Apart from any question as to the specific merits or otherwise of the engines, there are definite reasons for this

increase. At the present time the United States is the cheapest market in the world for the purchase of the raw materials from which a locomotive is made. Up to 1892 this was not the case, iron and steel costing more in America than in England, but now the conditions are reversed. Nominally labor is higher in the United States than in England, but in proportion to the output per man the labor cost of the product is lower in America, and while men receive higher wages they give proportionally more value.

Assuming, then, an equal product in both cases the American builder should be able to underbid his foreign competitor, and in many cases he is doing so.

In regard to differences of construction between the American locomotive builder and those of other countries, the variations which are observed are mainly those of local custom and usage rather than of fundamental importance. Many writers have treated this point as if there could be only one correct way to build a locomotive, and that to differ from this only true and correct model must be to stray from the straight and narrow path. As a matter of fact, the locomotives of nearly every country possess national characteristics which do not in the least affect the performance or efficiency, but which often strike the stranger as being peculiar.

It is certainly a mistake to assume that American locomotives built for foreign countries are all made after a cut-and-dried series of patterns, regardless of the work to be done or the fuel and water to be used. On the contrary, the details of design and the materials of construction are varied at all times to meet the requirements of the service. At the same time, in nearly every locomotive works the templates and patterns for every design are so carefully kept and recorded that any part can be reproduced upon order without delay, and all the modern processes of duplication are utilized to assist in the manufacture.

The growth in the foreign demand for American locomotives does not mean that there has been any falling off in English business in the same fields. On the contrary, the value of locomotives exported from Great Britain has increased from a

little more than \$4,000,000, in 1893, to nearly \$7,500,000, in 1898. The fact is that at the present time locomotive builders all over the world, like most other manufacturers, are filled with orders up to the limit of their capacity. This condition, however, cannot be expected to last, and when the competition for orders comes during a time when there is not more than enough work to go around, the experience gained during the present conditions may assist in determining where the greater portion of the work will be placed.

The Flow of Water Through Valves.

IN computing the flow of water through passages of various forms the question of frictional resistance is always an important factor, but while various formulas have been deduced for computing the retarding effect of friction in straight and curved pipes of various materials, very little information has been available regarding the obstructive action of the tortuous passages through which the water must flow in passing valves.

A number of interesting and valuable tests have recently been made under the direction of Professor W. T. Magruder, at the Ohio State University, and a paper based upon these tests has been read by him at the convention of the American Water Works Association and published in the *Engineering Record*, giving a summary of the information both in a graphical and a tabular form.

Most engineers have assumed that a gate valve will pass more water at a given pressure than will a globe valve of the same nominal size under like conditions, but this opinion has been formed from general principles and not upon exact data. An examination of drawings of the two kinds of valves will show that in a globe valve there are eleven distinct occasions for hydraulic losses, of which nine are enlargements or contractions, one is skin friction, and one the turning of the main direction of flow through 360°. In the case of the straight-way valve there are six changes of section, besides the skin friction.

In most valves the area of the valve orifice is not as large as the actual area of the pipe connected with it, and in many globe

and angle valves the disc does not rise enough to give the full value of even what opening there is.

The tests made at the Ohio State University were upon valves for pipes from three-eighth-inch to one and one-half inches nominal diameter, and from the account given by Professor Magruder every precaution seems to have been taken to secure accurate results. The water was delivered from the pumps into a stand-pipe, so that the pressure could be accurately regulated and measured, and the discharge through each valve was carefully measured. For the larger valves the discharge was measured by means of weirs, while for the smaller sizes the water was delivered directly into tanks for measurement. The runs were 20 minutes in duration in each test, and all the apparatus was carefully calibrated in order that the corrections might be made.

The best idea of the behaviour of the various valves is obtained from the curves given with the paper, but some general conclusions deduced from the diagrams will also be of interest. The amounts of water passed under given conditions by the gate and angle valves tested were approximately double and one and one-half times, respectively, the amount of water passed by the globe valves of the same nominal size under exactly the same conditions. That is, a straight-way valve is twice as good as a globe valve, and an angle valve is one and one-half times as good. Taking as the efficiency of a valve the ratio of the actual discharge to the theoretical discharge through a frictionless pipe of the same area under

the same conditions, we have a means of comparison of valves of different makes and styles which may be very convenient. The efficiency of a valve is not necessarily constant, and with valves of certain makes the efficiency of different sizes varies greatly. In some of the valves tested there was a pressure at which the maximum efficiency appeared, while for others the efficiency appeared to be the same at all pressures, and it seems to have been very definitely established that the better the quality of the valve the higher the efficiency.

As a result of these tests it would seem to be advisable to use a gate valve when the full capacity of the pipe is always desired, a globe valve being only used in a water line when excessive throttling of the quantity or pressure is immaterial. In the case of water distribution it appears that by the use of gate valves of the proper size, pressures one-quarter to one-half of those that would be needed with smaller valves would be sufficient. This may not hold true and exact with the large valves of city water works, but it doubtless does hold true with the smaller pumping plant and hydraulic elevator service of office buildings and the like.

The tests also show that there are many points about valves in which a slight modification would materially increase the efficiency with but slight increase in first cost, and the introduction of a testing plant similar to that described by Professor Magruder should enable manufacturers to make a marked improvement in their product in this respect.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s-q*, semi-quarterly, *etc.* Other abbreviations used in the Index are: *Ill*=Illustrated; *W*=Words; *Anon*=Anonymous.

American Architect. *w*. Boston, U. S. A.
American Electrician. *m*. New York.
Am. Engineer and Railroad Journal. *m*. New York.
American Gas Light Journal. *w*. New York.
American Geologist. *m*. Minneapolis, U. S. A.
American Journal of Science. *m*. New Haven, Conn.
American Machinist. *w*. New York.
Am. Manufacturer and Iron World. *w*. Pittsburg.
American Shipbuilder. *w*. New York.
Am. Soc. of Irrigation Engineers. *qr*. Denver
Annales des Ponts et Chaussées. *m*. Paris.
Architect. *w*. London.
Architectural Record. *q*. New York.
Architectural Review. *s-q*. Boston, U. S. A.
Architecture and Building. *w*. New York.
Architektonische Rundschau. *m*. Stuttgart.
Australian Mining Standard. *w*. Sydney.
Automotor and Horseless Vehicle Jour. *m*. London.
Berg-und Hüttenmännische Zeitung. *w*. Berlin.
Brick Builder. *m*. Boston, Mass.
Bridges. *m*. Chicago.
British Architect. *w*. London.
Builder. *w*. London.
Bulletin Am. Iron and Steel Asso. *w*. Phila.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m*. Brussels.

California Architect. *m*. San Francis co.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Montreal.
Canadian Mining Review. *m*. Ottawa.
Chem.Met.Soc.of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Contemporary Review. *m*. London.
Deutsche Bauzeitung. *b-w*. Berlin.
Dingler's Polytechnisches Journal. *w*. Stuttgart.
Domestic Engineering. *m*. Chicago.
Eclairage Electrique. *w*. Paris.
Electrical Engineer. *w*. London.
Electrical Engineering. *m*. Chicago, Ill.
Electrical Review. *w*. London.
Electrical Review. *w*. New York.
Electrical World. *w*. New York.
Electrician. *w*. London.
Electricien. *w*. Paris.
Electricity. *w*. London.
Electricity. *w*. New York.
Elektrochemische Rundschau. *b-m*. Frankfurt.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnisches Echo. *w*. Magdeburg.
Electrotechniker. *b-m*. Vienna.

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Eletticità, *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, U. S. A.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s. an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U. S. A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubb. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Heating and Ventilating. *m.* New York.
 Horseless Age. *w.* New York
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Engs and Surveyors. Peoria, U. S. A.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *w.* Calcutta.
 Indian Engineering. *w.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Master Steam Fitter. *m.* Chicago.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U. S. A.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna
 Ores and Metals. *w.* Denver, Colo.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York
 Proceedings Engineers' Club. *qr.* Phila.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U. S. A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Públicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, U. S. A.
 Sanitary Plumber. *s-m.* New York.
 Sanitary Record. *m.* London.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* Zürich
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, U. S. A.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Steamship. *m.* Leith, Scotland.
 Stevens' Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
 Trans. Am. Ins. Electrical Eng. *m.* w York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Western Railway Club Pro. Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, U. S. A.
 Year Book of Soc. of Engs. Univ. of Minn.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Expanded Metal.

Expanded Metal Construction at the Exposition (Le Métal Déployé à l'Exposition). With illustrations showing the manner in which expanded metal has been used in connection with reinforced concrete construction in several of the buildings of the Exposition of 1900. 1200 w. La Revue Technique—May 25, 1899. No. 28307 D.

Exposition.

The Buildings of the Paris Exposition. Jacques Boyer. Prof. Boyer's second paper describes with many handsome illustrations the structures now being erected on the banks of the Seine and on the Esplanade des Invalides. 3000 w. Engineering Magazine—July, 1899. No. 28387 B.

The International Exposition at Paris, 1900 (Die Weltausstellung, Paris, 1900). The first portion of a general description of the grounds and buildings of the exposition. Serial. Part I. 3500 w. Zeitschr d Ver Deutscher Ing—June 10, 1899. No. 28322 D.

The Textile Building of the Exposition of 1900 (Palais des Fils, Tissus, et Vêtements au Champ de Mars). L. Bourdain. A general description of this important structure of the exposition, with plate of details, and scaffolds for erection. 4000 w. 1 plate. Génie Civil—May 13, 1899. No. 28300 D.

Fireproofing.

Fireproof Floor Construction in California. G. W. Percy. Illustrates and describes the methods employed in the Wells-Fargo Building in San Francisco, and the Stanford University Library. 1000 w. Eng Rec—June 17, 1899. No. 28163.

Fire Tests of Fireproof Construction by the British Fire Preventive Committee. An outline of the proposed work, describing the testing plant and giving regulations governing the tests. Also editorial. Ill. 5400 w. Eng News—June 8, 1899. No. 28024.

Floors.

Economy in Floor Construction. Corydon T. Purdy. Gives plans for the floors of a warehouse made to enable the owners to decide for themselves which would be most desirable. 500 w. Br Build—June, 1899. No. 28289 C.

Hospital.

The Public Hospitals of Styria (Der Oeffentlichen Krankenpflege in Steiermark). Dr. E. Kleinsasser. With plans and details of arrangement of a number

of modern hospital buildings in the province of Styria, in Austria. 10000 w. 3 plates. Oesterr Monatschr f d Oeffentl Baudienst—June, 1899. No. 28334 D.

Mortar.

See Civil Engineering, Materials.

Ornamental Iron.

See Mechanical Engineering, Foundations.

Skeleton Construction.

The Use of Stone in Skeleton Construction. E. McL. Long. On the present practice in constructing steel-frame buildings, and the wrong ideas due to the habits acquired when stone was the strength-giving material. 2800 w. Bridges—June, 1899. No. 28239 C.

Stable.

A Hospital Stable. Describes the veterinary stable at Cornell University, which is fitted for the treating of sick animals. 1700 w. Eng Rec—June 3, 1899. No. 27976.

Structural Design.

Some Features of the Structural Design of Buildings. William H. Burr. Part first considers the need of the most advanced engineering principles in the construction of modern high buildings, and discusses foundations, metal frame-work, need of wind-bracing, etc. 14800 w. Jour Fr Inst—June, 1899. Serial. 1st part. No 27978 D.

HEATING AND VENTILATION.

Air Velocity.

Measurement of the Velocity of Air. R. C. Carpenter. Illustrates and describes some of the instruments and methods used, showing the difficulty in obtaining accuracy. 1500 w. Heat & Ven—June, 1899. No. 28292.

Exhaust Steam.

Exhaust Steam Central Heating Plant at Erie, Pa. Plans and information in regard to this installation for utilizing the exhaust steam of the electric railway and electric lighting stations. 700 w. Heat & Ven—May, 1899. No. 28018.

Hot Blast.

Design of Hot Blast Coils. Explains the methods of figuring coils for any given amount of work. 400 w. Eng Rec—June 3, 1899. No. 27975.

Jail.

The Ventilation of a Newark Jail. Illustrated description of a direct-indirect heating system with ventilation by means of a roof exhaust fan. 700 w. Eng Rec—June 10, 1899. No. 28078.

Radiators.

Air in Radiators. J. H. Kinealy. Explains why air gives trouble and the devices used to free the radiator but gives no solution of the problem. 1800 w. Heat & Ven—June, 1899. No. 28291

Residence.

Some Engineering Features of a Philadelphia Residence. Illustrates an unusually complete ventilating and heating system and electric lighting plant. 3500 w. Eng Rec—June 17, 1899. No. 28165.

Tests.

Test of a Blowing Fan in Connection with a Heating Coil. R. C. Carpenter. Describes tests made to investigate the capacity and efficiency of one form of heating surface in connection with a blowing fan. 2400 w. Heat & Ven—May, 1899. Serial. 1st part. No. 28019.

PLUMBING AND GAS FITTING.**Early Plumbing.**

Plumbing and Lead Work in the Olden Time. Paul Plimton. Part first considers the early use of lead pipe in water supply. 1200 w. San Plumb—June 1, 1899. Serial. 1st part. No. 28017.

Fittings.

See Gas Engineering.

Gas Pipes.

Gas Pipe Engineering. Gives points on the inspection and remedying of defects. Ill. 1300 w. Am Gas Light Jour—June 19, 1899. No. 28149.

Master Plumbers.

The Position of the Master Plumber as Regards the Sewerage of Cities and Towns. James F. Traynor. Read at convention of the N. A. M. P. at New Orleans. Discusses the influence of the plumber in relation to the public health. 2400 w. Dom Engng—June, 1899. No. 28198 C.

Office Building.

Plumbing in the Empire Building, New York. Illustrated description of the numerous novel devices employed in plumbing a 21-story, 224 x 78 ft. office building. 3000 w. Eng Rec—June 24, 1899. No. 28235.

Piping.

See Gas Engineering.

Yacht Plumbing.

See Marine and Naval Engineering.

MISCELLANY.**Mechanical Influence.**

Mechanical Influence in Architecture. G. W. Percy. The writer claims that the most influential factor in perfecting architectural forms has been purely mechanical, in devising the best methods of employing the materials, and the means used to overcome structural difficulties. 7700 w. Jour Assn of Engng Socs—April, 1899. No. 27013 C.

Moving Buildings.

See Civil Engineering, Miscellany.

CIVIL ENGINEERING**BRIDGES.****Arch.**

The Bellefield Arch Bridge in Schenley Park, Pittsburg, Pa. Illustrated description of the construction of a handsome stone arch of 150 ft. span. 2000 w. Eng News—June 22, 1899. No. 28211.

The Kaiser Wilhelm Bridge. Illustrated description of the design and method of erection. Span, 525 ft.; total height, 350 ft. 4000 w. Eng Rec—June 10, 1899. No. 28071.

Atbara.

The Atbara River Bridge. Comment on the object lesson taught to British makers by the contract for this bridge, which was given to an American firm, discussing the causes and giving a brief history of the work. 2200 w. Engng—June 9, 1899. Serial. 1st part. No. 28180 A.

Concrete Construction.

Concrete in Railway Bridge Construc-

tion. H. W. Parkhurst. An illustrated critical review of the bridges on the Illinois Central System, with comment on the economy and usefulness of concrete construction, and a statement of the general principles of good concrete. 5500 w. Bridges—June, 1899. No. 28241 C.

Failure.

A Curious Railway Trestle Bridge Failure. Brief illustrated description of the collapse of a timber trestle under an ore train on the Belt Line branch of the Great Northern Railway, near Superior, Wis. 600 w. Eng. News—June 15, 1899. No. 28103.

India.

Bridges in India. Information relating to the work of F. E. Robertson and the recent bridge structures in India. Ill. 2700 w. Bridges—June, 1899. No. 28240 C.

Kornhaus Bridge.

Construction of the Kornhaus Bridge

Berne, Switzerland. Illustrated description of the details and methods of construction. This is a steel bridge of six arch spans, the largest of 377 feet. 2500 w. Eng Rec—June 17, 1899. No. 28156.

Lift Bridge.

The Morison Lift Bridge Over the Chicago River. Illustrates and describes a special design of bascule bridge, differing from other bascule bridges mainly in the driving machinery and the method of counter weighting. 600 w. R F Gaz—June 2, 1899. No. 27938.

Renewal.

Renewal of the Swing Bridge at Gramhamstown, N. B. An illustrated account of the removal of a hand-power single-line swing bridge, and replacing it by a double-line swing bridge worked by hydraulic machinery. 1800 w. Transport—May 26, 1899. No. 27994 A.

Rhine.

The New Bridges Over the Rhine (Les Nouveaux Ponts sur le Rhin). H. Martin. A very fully illustrated account of the new bridges across the Rhine at Bonn and at Dusseldorf. Two articles. 1 plate. 5000 w. Le Génie Civil—May 20, 27, 1899. No. 28301 each D.

Richmond, Ind.

Bridges Over the Whitewater River at Richmond, Ind. Illustrates and describes a number of interesting structures. 600 w. Eng News—June 22, 1899. No. 28209.

Short Spans.

Some Short Span Railway Bridges. Illustrates two bridges on the Chicago and Northwestern Railway having unusually shallow floors and special details in connections. 1600 w. Eng Rec—June 3, 1899. Serial. 1st part. No. 27969.

Viaduct.

The Manhattan Valley Viaduct, New York City. Illustrated detailed description of the viaduct to carry the extension of Riverside Drive, from 127th street to 135th street, in New York. 1900 w. Eng News—June 8, 1899. No. 28023.

CONSTRUCTION.

Military Work.

I. Work and Experiences of the 1st Battalion, 1st Regiment, U. S. Volunteer Engineers, in Porto Rico. John Stephen Sewell. II. Work of the Third Regiment, U. S. Volunteer Engineers, in Cuba. Lyle F. Bellinger. Two letters describing work actually performed. 5400 w. Eng News—June 22, 1899. No. 28215.

Park Work.

Park Work at the Orchard Knob Battle Field. Describes the methods followed

in building streets and gutters, ornamental walls, surface drains, etc. 1500 w. Eng Rec—June 24, 1899. No. 28232.

Pipes.

Laying Submerged Pipes. Part first gives an illustrated description of various methods which have been adopted in executing such work. Eng Rec—June 24, 1899. Serial. 1st part. No. 28228.

Roads.

Road Construction at Geneva, N. Y. Describes the manner in which an 8,000 population town is working out its good-roads problem. 1000 w. Eng Rec—June 24, 1899. No. 28231.

Road Making in Ontario. Gives the results of the recent attempts to improve the roads of the province, and the methods which seem most promising in securing better highways without prohibitive expense. 1700 w. Eng Rec—June 10, 1899. No. 28074.

The Development of Roads and Street Pavements. Francis W. Blackford. Describes ancient and modern road construction, and the various forms of paving, favoring properly constructed wooden blocks and asphalt pavings. 5800 w. Jour Assn of Engng Socs—April, 1899. No. 27915 C.

Tunnels.

The Boring of the Simplon Tunnel. (Die Durchbohrung des Simplon). H. Claus. A very complete description of the inception, progress and present state of this work, with sketch map and sections of the tunnel. 7000 w. Glaser's Annalen—May 15, 1899. No. 28347 D.

The Proposed East River Tunnel. Brief account with illustrations of the tunnel proposed by the Long Island Railroad Co., with references also to other projects. 1200 w. Sci Am—July 1, 1899. No. 28296.

HYDRAULIC AND MARINE.

Breakwaters.

Notes on the Effects of Waves on Breakwaters in Different Depths of Water. William Shield. Read at the Engineering Conference of the Inst. of Civil Engs., England. A study of wave action, comparing facts and theories. 2000 w. Engr. Lond—June 16, 1899. No. 28253 A.

The Design of Breakwaters. J. Watt Sandeman. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Considers the facts that determine the general character, position and principal proportions. 2200 w. Engr. Lond—June 16, 1899. No. 28254 A.

Calcutta.

The Port of Calcutta. Charles Cecil Stevens. Descriptive, with an account of

the harbor improvements and topics relevant to the subject. Discussion. 17200 w. Jour Soc of Arts—June 16, 1899. No. 28244 A.

Canals.

The Marseilles-Rhône Canal. (Le Canal de Marseille au Rhône). G. Leugny. A discussion both of the economic and engineering features of the proposed canal, with map of the route and sections at various points. 3000 w. La Revue Technique—May 25, 1899. No. 28308 D.

The New Trans-Isthmian Canal Commission. Editorial comment on the members of the commission and outline of the recent history of the project. 2500 w. Eng News—June 15, 1899. No. 28107.

The Report of the Nicaragua Canal Commission. Briefly compares the various reports, and shows the limited nature of investigations hitherto authorized by Congress, as compared with that ordered in 1899. 1500 w. Eng Rec—June 10, 1899. No. 28070.

Chambly.

The Hydraulic Features of the Chambly Water Power. Illustrated description of the dam and water-wheel plant of a large station on the Richelieu River, near Montreal. 700 w. Eng Rec—June 17, 1899. No. 28157.

Conduit.

Conduit of Sheet Steel. (Conduite en Tôle d'Acier). A description of a steel conduit 2.4 metres in diameter spanning the River Arc in the form of an arch of 50 metres span. The computations are also given for a similar structure of reinforced concrete. 1200 w. La Revue Technique—June 10, 1899. No. 28313 D.

Dams.

Partial Failure of the Timber Crib Dam of the Montana Power Company, near Butte, Montana. M. S. Parker. Gives a general description and details of the causes of the partial failure, with the object of calling engineers' attention to elements to be guarded against in the construction of such dams, and the precautions necessary. Ill. 9000 w. Jour Assn of Engng Socs—April, 1899. No. 27916 C.

The Construction of a Crib Dam for the Butte City Water Co. Eugene Carol. A description of the construction, with reasons for the adoption of the design. Short discussion. Ill. 3000 w. Jour Assn of Engng Socs—April, 1899. No. 27917 C.

Drainage.

State Drainage Work in the Red River Valley, Minnesota. Information from the last biennial report of the State Drainage Commission, stating the condi-

tions and the success. 1000 w. Eng News—June 15, 1899. No. 28108.

Dredgers.

Sand Pump Dredgers. Anthony Geo. Lyster. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Information of the work on the Mersey Bar by dredging, especially since 1893. 1400 w. Engng—June 16, 1899. No. 28272 A.

Dry Dock.

The Dry Dock of Talcahuano, Chile (Das Trockendock von Talcahuano, Chile). A detailed account of this fine masonry dock, with map of the Bay of Concepcion, and drawings of the masonry construction and gates. 5000 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1899. No. 28328 B.

Flow.

The Flow of Water. Editorial discussing Prof. Hele-Shaw's experimental method of studying the flow of a perfect liquid. 2000 w. Eng Rec—June 24, 1899. No. 28227.

The Motion of a Perfect Liquid. A. S. Hele-Shaw. An illustrated study of stream lines and the behavior of liquids. 7000 w. Engr, Lond—June 2, 1899. No. 28299 A.

Index.

The Colton Index to Hydraulics. Describes a card index of literature on the whole field of hydraulic engineering, now preserved at Yale University. It illustrates the usefulness of this system when applied to one subject. 1200 w. Eng Rec—June 17, 1899. No. 28162.

Irrigation.

Irrigation in Mexico. An account of proposed undertakings which will undoubtedly be of great benefit to the country. 1100 w. U. S. Cons. Repts, No. 451—June 14, 1899. No. 28099 D.

Lock.

The Hotopp System of Locks for the Elbe-Trave Canal (Die Hotoppschen Betriebseinrichtungen der Schleusen des Elbe-Trave-Kanals). H. Arnold. With plans and sections of the lock and a description of its operation. 2500 w. Zeitschr d Ver Deutscher Ing—May 27, 1899. No. 28320 D.

Porto Rico.

The Engineering Development of Porto Rico. Herbert M. Wilson. A review of the commercial engineering possibilities of the island, with especial regard to the utilization of the numerous water powers available. 4000 w. Engineering Magazine—July, 1899. No. 28384 B.

Stave Pipe.

Stave Pipe; Its Economic Design and

Use. Arthur L. Adams. A discussion, with illustrations, of the essential considerations in stave-pipe design, and some of the limitations imposed; with a study of existing lines, and a comparison with leading types of large pressure pipes. 10900 w. Jour N E Water Wks Assn—June, 1899. No. 28110 E.

Water-Pipe.

Improved Wyckoff Water-Pipe. Geo. L. Wells. Gives a brief description of this pipe and its manufacture, discussing details. Ill. 5400 w. Jour N E Water Wks Assn—June, 1899. No. 28111 E.

The Use of Steel for Water Mains. L. M. Hastings. States the few conditions and situations where steel seems best adapted for use, and the principal advantages, discussing cost, protective coating, durability, etc. 3000 w. Jour N E Water Wks Assn—June, 1899. No. 28113 E.

Water Pipes on Metropolitan Water Works. Dexter Brackett. Brief account of the pipes made of steel plates used in Boston. 2500 w. Jour N E Water Wks Assn—June, 1899. No. 28114 E.

MATERIALS.

Asphalt.

Residuum as Flux for Asphalt. Clifford Richardson. A criticism of statements made by A. W. Dow in his annual report, with results of experiments made by the writer. 800 w. Munic Engng—June, 1899. No. 27918 C.

Cement.

Cement and Cement Testing. Robert W. Lesley. The paper aims to give, both from the manufacturer's and engineer's points of view, some idea of the various specifications that have to be met in the use of cement, the difficulties in the testing, and of the machinery, with some description of the laboratories in this country and in Europe. Ill. 8000 w. Pro Eng's Club of Phila—May, 1899. No. 27910 D.

Concrete.

Concrete for Street Work. Describes the construction of concrete curbs, sidewalks and streets in Iowa. 1500 w. Eng Rec—June 3, 1899. No. 27971.

On the Theory of Concrete. George W. Rafter. Results of tests made by the author, with details of the work. 2000 w. Pro Am Soc of Civ Eng's—April, 1899. No. 28118 E.

Mortar.

Sand for Mortar. Ira O. Baker. The importance of the quality on the strength and durability of the mortar is shown, and the requirements of a good building sand are discussed. 2500 w. Br Build—June, 1899. No. 28288 C.

Reinforced Cement.

The Development of Reinforced Cement Construction (Evolutions des Constructions en Ciment Armé). A brief review of the various systems of strengthening cement and concrete work with embedded metal. 2000 w. La Revue Technique—June 10, 1899. No. 28312 D.

Testing Laboratory.

A Few Remarks on the Testing Laboratory of the City of Philadelphia. Richard L. Humphrey. Describes recent additions in the equipment of the laboratory, and gives some results of tests which have been made. Discussion. Ill. 4500 w. Pro Eng's Club of Phila—May, 1899. No. 27911 D.

Volcanic Products.

The Utilization of Volcanic Products. Discusses this new material being introduced for use of dock and railway contractors, builders, etc. Basalt, lava stone, and trass. 3500 w. Engr, Lond—May 26, 1899. No. 28013 A.

MEASUREMENT.

Surveys.

Surveys in Tropical Forests. From a paper by Frederic Shelford, recently contributed to the Institution of Civil Eng's. Describes methods employed in Africa and Central and South America. 2000 w. Eng Rec—June 3, 1899. No. 27973.

Transition Curves.

Laying Down Transition Curves by Offsets. Shows a transition curve based upon the cubic parabola, and describes the method of laying it out. 700 w. Eng News—June 22, 1899. No. 28213.

Triangulation.

The Invention of Triangulation. (Die Erfindung der Triangulierung). S. Welisch. An examination into the history of modern surveying, showing the earliest use of triangulation to have been by Augustin Hirschvogel, in 1547. at Vienna. 1500 w. Zeitschr d Oesterr Ing u Arch Ver—May 19, 1899. No. 28329 B.

MUNICIPAL.

Bathing Plant.

Boston's Free Municipal Bathing Plant. J. A. Stewart. Illustrated detailed description. 1200 w. Sci Am Sup—June 24, 1899. No. 28202.

Filtration.

The Operation of Water Filters in Germany. Translation of the official regulations for the operation of filters during times of cholera which are also advised for regular service. 1600 w. Eng Rec—June 10, 1899. No. 28076.

The Slow Sand Filtration Plant for

Little Falls, N. Y. Describes a plant containing some unique features, now being built for the city named. 1600 w. Eng News—June 22, 1899. No. 28212.

Fire Protection.

Salt Water Fire System of Boston. Frank A. McInnes. Describes the system which aims to extend the action of the fire boats, so that the power may be available at a distance from the water front. Ill. 2700 w. Jour N E Water Wks Assn—June, 1899. No. 28112 E.

The City's Fire Hydrants, Water Pressure and Meters. Information brought out in the testimony at the Mazet investigation. 2500 w. Fire & Water—June 10, 1899. No. 28069.

Water Curtains for the Fire Protection of the Chicago Public Library. Illustrates and describes the system. 1100 w. Eng News—June 8, 1899. No. 28025.

Flood Water.

The Use of Filtered Flood Water. M. W. Hervey. Read at the Engineering Conference of the Inst. of Civ. Engs., England. Discusses the flood waters of the rivers Thames and Lea. 1500 w. Engr, Lond—June 16, 1899. No. 28256 A.

Kansas City.

Public Works in Kansas City. Describes recent street work, trouble with smoke, and the reconstruction of a reservoir with partially fallen walls. 900 w. Eng Rec—June 17, 1899. No. 28160.

Porto Rico.

A Porto Rican Well. Illustrates a well having a brick curb 7 to 9 feet in diameter and considerably over 100 feet deep. 600 w. Eng Rec—June 17, 1899. No. 28158.

Refuse.

Refuse Disposal in New York in 1898. Describes the experience with garbage reduction and cremation in the various boroughs, and gives the cost of sorting salable refuse. 1100 w. Eng Rec—June 10, 1899. No. 28073.

Reservoirs.

A Great Excavation and Embankment Contract. Gives a summary of the important requirements for clearing most of the Wachusett reservoir basin. 1200 w. Eng Rec—June 10, 1899. No. 28075.

Recent Reservoir Linings. Illustrated account of the methods followed at Black Hawk, Col., and Coatsville, Pa., in laying brick and asphalt linings, and at Lancaster, Ohio, with a concrete and brick lining. 1000 w. Eng Rec—June 24, 1899. No. 28233.

Sewage Disposal.

Notes on the Berlin Sewage Farms.

James H. Fuertes. Illustrated article on details of these farms not before made public. 600 w. Eng Rec—June 10, 1899. No. 28072.

Sewage Sludge Disposal by Natural Agencies. G. Sims Woodhead. Read at the Engineering Conference of the Inst. of Civ. Engs., England. Brief notes on the treatment of solid matter in sewage. 1100 w. Engr, Lond—June 16, 1899. No. 28258 A.

The Purification of the Thames, England. Gives the results which have followed the chemical clarification of London sewage. 2000 w. Eng Rec—June 17, 1899. No. 28161.

Sewer Pipe.

Sewer Pipe; Its Manufacture. A complete account of the process, including water smoking, heating up, vitrifying, salting and cooling. 4300 w. Brick—June 1, 1899. No. 28030.

Sewers.

A Constant Flow Sewer Regulator. Illustrated description of apparatus used to maintain a constant flow from a branch sewer into an interceptor, no matter what the height of water in the latter. 350 w. Eng Rec—June 24, 1899. No. 28229.

A New Method of Ventilating Sewers. Charles Cameron. Read at a meeting of the Royal Inst. of Archts. of Ireland, May 25, 1899. Describes a sewer diffuser ventilator, which has given satisfaction in Dublin. 1300 w. Builder—June 17, 1899. No. 28245 A.

Sewer Construction and Maintenance. Report of a discussion in which the views of a number of New England engineers were given. 3500 w. Eng Rec—June 24, 1899. No. 28230.

The Sewerage of London, England. History of the works and a statement of their size and effect on the Thames. 3500 w. Eng Rec—June 3, 1899. No. 27977.

Sterilization.

See Electrical Engineering, Electrochemistry.

Substructures.

The Economic Arrangement and Construction of Sub-Structures in Streets. H. C. Hodgkins. Read at Columbus, Ohio, convention of the Am. Water Works Assn. Advocates the building of subways under the sidewalks, showing that the plan has much in its favor. 3200 w. Fire & Water—June 24, 1899. No. 28242.

Subways.

Subways for Street Pipes. Abstract of a paper by H. C. Hodgkins before the Am. Water Works Assn. advocating subways under sidewalks. 1400 w. Eng Rec—June 3, 1899. No. 27974.

Water Analysis.

The Saline Constituents of Water from the Chalk. J. C. Thresh. Read before the British Assn. of Water Works Eng. On the importance of a systematic record being kept of the analyses and other information concerning water supplies. Gives analyses of chalk waters. Discussion. 4000 w. Jour Gas Lgt—June 13, 1899. No. 28194 A.

Water Main.

Cleaning a Water Main in St. John, N. B. William Murdoch. Describes the process used and reports the improvement in pressure and satisfactory results. 3000 w. Jour N E Water Works Assn—June, 1899. No. 28115 E.

Water Meters.

The Results of the Meter System in Richmond, Va. A description, with diagram, of the effect of meters on the pressure in street pipes. 900 w. Eng. Rec—June 3, 1899. No. 27972.

Water Supply.

A Consideration of the Rate per Head per Day of Supply in Different Towns, and the Causes Which Increase or Diminish It in Particular Instances. James Watson. Read at the Engineering Conference of the Inst. of Civ. Eng., England. Discusses some of the more important causes. 1500 w. Engr, Lond—June 16, 1899. No. 28257 A.

London Water Supply. Tables and diagrams showing the rainfall at Greenwich, and a discussion of the sources of supply and the effect of dry weather. 2000 w. Engr, Lond—May 19, 1899. No. 27902 A.

Water Supply of Philadelphia. Communications from John C. Trautwine, Jr., and Edgar Marburg, presented at a special meeting held March 25, 1899, to discuss the present problem of the water supply. Also general discussion by Messrs. Hicks, Schermerhorn and Fuller. 5000 w. Pro Eng's Club of Phila—May, 1899. No. 27912 D.

Water-Works.

A Lesson in Water-Works Management. An account of the partial wreck of a water-works by incompetent management. 900 w. Eng Rec—June 17, 1899. No. 28159.

The Waterworks of Bergisch-Gladbach. (Das Wasserwerk der Stadt Bergisch-Gladbach). H. Ehlert. An illustrated description of the plant by which a town of 10,000 inhabitants is supplied from ground-water sources. 5000 w. Zeitschr d Ver Deutscher Ing—June 17, 1899. No. 28326 D.

The Water-Works of Columbus, Ohio. Illustrated description of one of the largest plants in the United States drawing water from filter conduits. 3600 w. Eng Rec—June 3, 1899. No. 27970.

Water-Works in Russian Cities. Translation of the specifications for the proposed works for the city of Nicolaiev, Russia. 1300 w. U. S. Cons. Repts, No. 450—June 13, 1899. No. 28097 D.

MISCELLANY.**Afghanistan.**

Engineering in Afghanistan. Reviews the work accomplished and the mechanical progress which has been made in Kabul. 1700 w. Ind & East Engr—May, 1899. No. 28096 D.

Moving Buildings.

Raising and Moving Large Buildings. Illustrates and describes two pieces of difficult work. The first, the removal of the town hall at Washington, Pa.; the second, the reconstruction of the lower portion of the Mandel Building, Chicago. 1000 w. Eng News—June 1, 1899. No. 27929.

Santiago.

Engineering Notes at Santiago de Cuba. H. M. W. Describes the topography, and gives information concerning the sanitary condition, water supply, streets, harbor, etc. 3500 w. Eng News—June 8, 1899. No. 28026.

ELECTRICAL ENGINEERING**COMMUNICATION.****China.**

Electrical Notes in China. Francis B. Crocker. Part first discusses the development of the telegraph and the difficulties arising from the hostility of the natives. Describes the process of sending a Chinese telegram. 1500 w. Elec Wld & Elec Eng—June 17, 1899. Serial. 1st part. No. 28124.

Coherer.

The Substitution of Magnetic for Me-

chanical Action in a Coherer (Sur la Substitution de l'Action Magnétique à l'Action Mécanique du Trembleur). Th. Tommasina. A communication to the French Academy showing how the mechanical tapping for de-cohering may be advantageously replaced by the action of a magnet. 500 w. L'Electricien—June 10, 1899. No. 28375 B.

Earth Currents.

Atlantic Earth Currents. E. Raymond-Barker. An interesting record of earth-

current observations made by the writer on a submarine cable. 700 w. *Elec Rev*, Lond—June 9, 1899. No. 28177 A.

Interconnecting.

Switchboard Operator's Interconnecting Equipments. H. P. Clausen. Discusses the means that may be devised for connecting together and controlling the switchboard terminals of two or more centralized telephone circuits. Ill. 3000 w. *Elec Engr*—June, 1899. Serial. 1st part. No. 28219.

Space Telegraphy.

Experiments with Wireless or Space Telegraphy. Dr. I. Kitsee. Describes a series of experimental tests and gives the deductions drawn from them, and the practical applications possible, describing an arrangement that it is believed will effectually prevent collisions on steam roads. 2500 w. *Elec Wld & Elec Engr*—June 24, 1899. No. 28217.

On Wireless Telegraphy. A. S. Dolbear. Recalls some early experiences with the telephone which were explained as due to induction, reviews experiments of Prof. Trowbridge, made in 1880, and also of others, calling attention to the distinction between conduction and induction. 2500 w. *Elec Wld & Elec Engr*—June 10, 1899. No. 28060.

The Experiments of Prof. Hughes on Ether Telegraphy. J. Munro. An account of the original experiments of Prof. Hughes, showing that he discovered all the elements of wireless telegraphy as now known, nearly twenty years ago. 2200 w. *Elec Rev*, Lond—June 2, 1899. No. 28083 A.

Telegraphs.

An Imperial Telegraph System. J. Henniker Heaton. Considers the high charges for telegrams to all parts of the British Empire, proposes a remedy, and discusses the scheme. 3500 w. *Nineteenth Cent*—June, 1899. No. 28153 D.

Telegraph Lines.

Construction and Reconstruction of Telegraph Lines. C. H. Bristol. Condensed paper, read before the Assoc. of Ry. Telegraph Supts. at Wilmington, N. C. Reviews recent improvements in this work, describing the most approved construction. 1800 w. *R R Gaz*—June 2, 1899. No. 27939.

Telephones.

Germain's Loud-Speaking Telephone. L. Leroy, in *La Nature*. Illustrated description of the instrument. 800 w. *Sci Am Sup*—June 3, 1899. No. 27943.

Some Problems in Telephone Engineering. Theodore Spencer. Briefly outlines the general system of telephone lines as now used, discussing a few prominent details, and stating the prob-

lem as it appears at present, and some possible methods of solving the difficulties. Ill. 3800 w. *Pro Engs' Club of Phila*—May, 1899. No. 27909 D.

Telephone Relays or Repeaters. William J. Hammer. Describes experiments, giving an analysis of the scientific phenomena connected with them. Ill. 2300 w. *Elec Wld & Elec Engr*—June 3, 1899. No. 27982.

Telephone Repairs.

Minor Telephone Troubles and How to Correct Them. H. P. Clausen. A general discussion of telephone repairs. 2000 w. *W. Electr'n*—June 24, 1899. No. 28243.

DISTRIBUTION.

Alternating Currents.

Three-Phase Four-Wire Low-Tension Systems. A. J. Bowie, Jr. Describes a plant of this kind and tests made on it. 2400 w. *Elec Wld & Elec Engr*—June 17, 1899. No. 28123.

Arresters.

Lightning Arresters for Electric Conductors (*Les Parafoudres sur les Canalisations Electriques*). M. Bochet. A paper read before the *Societe Internationale des Electriciens*, with illustrations of various forms of arresters. 7500 w. *Bull de la Soc Int des Electriciens*—April, 1899. No. 28367 F.

Construction.

Underground Electrical Construction. L. A. Ferguson. Abstract of a paper read at the recent convention of the Nat. Elec. Lgt. Assn., in New York. Part first describes the Edison tube for feeders. 1400 w. *Elec Wld & Elec Engr*—June 24, 1899. Serial. 1st part. No. 28218.

Converter.

The Rotary Converter. E. W. Rice, Jr. Sketches the development of the more important systems of distribution and reviews their present standing, showing the necessity for some practical connecting link, which is found in the converter. 8000 w. *Sib Jour of Engng*—June, 1899. No. 28126 C.

Polyphase System.

A New System of Polyphase Generation. Concerning the system developed by C. P. Steinmetz, considering some of the direct applications of the principle suggested. Ill. 2000 w. *Elect'n*, Lond—June 9, 1899. No. 28175 A.

Regulations.

Safety Regulations for Electric Currents of Moderate Pressure (*Sicherheitsvorschriften für Elektrische Mittelspannungs-Anlagen*). The full text of the

regulations reported by the committee of the German Electrotechnical Society for use in connection with currents of pressures between 250 and 1000 volts. 6000 w. *El-ktrotech Zeitschr*—May 18, 1899. No. 28355 B.

Safe Methods.

Means of Attaining Safety in Electrical Distribution. W. L. R. Emmet. Read before the Nat. Elec. Assn at New York. Considers the principal sources of danger and considers methods for securing safety. Ill. 3300 w. *W Elect'n*—June 3, 1899. No. 28022.

Single-Phase.

Single-Phase Distribution of Electric Current. Herbert A. Wagner. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. Describes the results obtained by the Missouri-Edison Electric Co., of St. Louis. 1900 w. *Eng News*—June 1, 1899. No. 27931.

Underground.

Some Notes on Underground Distribution of Two-phase Currents in New York City. E. A. Leslie. Abstract of paper read before the Nat. Elec. Lgt. Assn. Describes the system and explains why it was adopted; gives the method of testing for faults, testing insulation resistance of the line circuits, etc. 2400 w. *Elec Wld & Elec Engr*—June 17, 1899. No. 28125.

Wiring.

A Universal Electric Wiring Chart. Sanford H. Fry. Chart and formula for solving problems pertaining to electric wiring for the transmission of energy. 700 w. *Am Mach*—June 22, 1899. No. 28197.

The Computations of a Wiring System for Incandescent Lamps (*Calcul d'une Canalisation Electrique pour Lampes à Incandescence*). A. Vallée. A mathematical computation, taking into account leakage, heating, economy of copper, and the various elements which enter in practical work. Three papers. 2500 w. *L'Electricien*—May 6, 13, 20, 1899. No. 28369 each B.

ELECTRO-CHEMISTRY.

Accumulators.

The Blot Accumulator (*Der Akkumulator Blot*). Showing the details of the lead band construction and giving data and results of tests. 2500 w. *Elektrochemisch Zeitschr*—June, 1899. No. 28366 H.

Notes on the Theory of the Lead Accumulator (*Beiträge des Blei-Akkumulators*). F. Dolezalek. A mathematical discussion, taking into account the degree of concentration of the acid solution and its effect upon the electromotive force.

3000 w. *Zeitschr f Elektrochemie*—May 25, 1899. No. 28364 H.

Storage Batteries. E. L. Nichols. Reviews the processes of Faure and Planté for the production of the plates, modifications of the grid, etc., noting the most important applications of the storage battery. 1600 w. *Sib Jour of Engng*—June, 1899. No. 28133 C.

Battery.

A New Primary Battery Cell of Large Capacity and high economy. From *Cosmos*. Illustrates and describes the Jeanty cell. 1200 w. *Sci Am Sup*—June 24, 1899. No. 28203.

Bleaching.

Electrical Bleaching (*Elektrische Bleiche*). Victor Engelhardt. A description of the process and apparatus used at the bleachery of Gebauer at Charlottenburg, with data of production and cost. 1000 w. *Elektrochemische Zeitschr*—May, 1899. No. 28365 H.

Chemical Reaction.

Dr. Tommasi "On the Law of the Proportionality of the Electromotive Force of Decomposition." Abstract of paper published in the *Bulletin Technique*. Gives experiments which the writer considers sufficient to disprove Berthelot's law of maximum work, and Sprague's law of minimum work, and formulates a new principle, termed the "principle of least work." 2200 w. *Elec Rev, Lond*—June 2, 1899. No. 28085 A.

Chlorate Works.

The Electrolytic Chlorate Works at Chedde, Savoy. John B. C. Kershaw. Facts showing the progress of the new method of manufacture, and giving an account of the works situated at Chedde, Haute Savoie, close to Chamounix. 2300 w. *Eng & Min Jour*—June 10, 1899. No. 28066.

Electro-Metallurgy.

Electro-Metallurgy as a Department of Electrical Engineering. R. H. Thurston. A review of the origin, progress, and present status of the art, illustrating its principles and practice by the aluminum industry. *Sib Jour of Engng*—June, 1899. No. 28131 C.

Sterilization.

The Sterilization of Potable Water (*Sur la Sterilisation Industrielle des Eaux Potables*). MM. Marmier and Abraham. A discussion of the experiments made at Lille upon the sterilization of water by ozone, with comments upon the official report. 1000 w. *L'Electricien*—June 3, 1899. No. 28374 B.

The Sterilization of Water (*La Sterilisation de l'Eau*). E. Andreoli. A criticism of the report of the Marmier and

Abraham ozone process as employed at Lille. 1200 w. *L'Electricien*—May 13, 1899. No. 28371 B.

ELECTRO-PHYSICS.

Interrupter.

The Wehnelt Electrolytic Interrupter. Ernest Merritt. A statement of some of the chief characteristics, with especial reference to its use. 1500 w. *Sib Jour of Engng*—June, 1899. No. 28132 C.

Theory.

Hydrodynamic Analogies to the Theory of Potential and Electrotechnics (*Hydrodynamische Analogien zur Theorie des Potentials und der Elektrotechnik*). Dr. Holzmüller. A comparison between the laws and phenomena of hydrodynamics and those of electricity, showing the close analogy. Two articles, 7000 w. *Zeitschr d Ver Deutscher Ing*—June 3, 10, 1899. No. 28321 each D.

Vector Diagrams.

The application of Vector Diagrams to the Flow of Alternating Currents (*Ueber die Anwendung des Vektordiagramms*). Dr. F. Breisig. Devoted especially to the consideration of flow in long circuits with high tensions. Two articles, 9000 w. *Elektrotech Zeitschr*—June 1, 8, 1899. No. 28360 each B.

GENERATING STATIONS.

Barking, Eng.

Barking Electricity Works. Illustrated detailed description of the works, with history of the undertaking. 2800 w. *Elec Eng, Lond*—June 2, 1899. No. 28086 A.

Brooklyn Station.

The Development and Operation of a Local Electrical Transmission System. W. S. Barstow. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. An account of the station of the Brooklyn Edison Electric Co., with the distribution and operation. 5000 w. *Eng News*—June 1, 1899. No. 27930.

Electric Supply.

The Newington Vestry Electric Supply Works. Illustrated detailed description, with historical account of this London plant. 2800 w. *Elect'n, Lond*—June 9, 1899. No. 28174 A.

Friction.

Friction Losses in Electrical Machinery (*Die Reibungsverluste in Elektrischen Maschinen*). G. Dettmar. A very complete investigation of journal friction in dynamos and motors taking into account the various temperatures and pressures. Two articles, 10000 w. *Flektrotech Zeitschr*—June 1, 8, 1899. No. 28359 each B.

Isolated Plant.

The Largest Isolated Electric Light Plant in the World. Illustrated description of the plant of the Waldorf-Astoria, in New York. 3200 w. *Power*—June, 1899. No. 27934.

Montmorency Falls.

Development of the Montmorency Falls. E. M. Archibald. Illustrates and describes the power plant and system of distribution. 4800 w. *Elec Wld & Elec Engr*—June 17, 1899. No. 28120.

Transformation.

Methods of Electrical Transformation. James Swinburne. Read before the British Inst. of Civ. Engs. Also discussion. Considers the various systems and the questions of copper and insulation. 2200 w. *Elec Eng, Lond*—June 9, 1899. No. 28168 A.

Transformers.

Transformers: Iron Loss—Its Increase—The Remedy. G. Wilbur Hubley. Read before the Nat. Elec. Lgt. Assn., New York. The writer has studied this subject carefully for several years and gives data, tests, etc., compiled from actual facts and conditions. 2200 w. *Elec, N. Y.*—June 7, 1899. No. 28044.

Watford, Eng.

Watford Municipal Electric Supply Works. Illustrates and describes these works, which possess several novel features. 2000 w. *Elect'n, Lond*—June 2, 1899. No. 28087 A.

HEATING AND WELDING.

Rail Welding.

The Present Status of Electric Welding of Rails. H. F. A. Kleinschmidt. Describes the excellent results obtained by the Lorain Steel Co., by making a weld from a boss on a bar, instead of from a flat bar. 1000 w. *St Ry Jour*—June, 1899. No. 27949 D.

LIGHTING.

Nernst.

The Nernst Incandescent Lamp (*Die Nernstsche Glühlampe*). An abstract of an address recently delivered by Prof. Nernst, giving details concerning the construction and performance of his new incandescent lamp. 1500 w. *Elektrotech Zeitschr*—May 18, 1899. No. 28356 B.

The Nernst Lamp of the Allgemeinen Elektrizitäts-Gesellschaft, Berlin. (*Die Nernst-lampe der Allgemeinen Elektrizitäts-Gesellschaft, Berlin*). An address given by the inventor at a public exhibition of the Nernst lamp in Berlin, showing the importance of the invention

and the relation it bears to its predecessors. 2500 w. Glaser's Annalen—June 1, 1899. No. 28349 D.

Socket.

Standard Socket and Bayonet Fastening for Incandescent Lamps (Normalien für Glühlampenfüsse und Fassungen mit Bajonettkontakt). Abstract from the report of the committee of the German Electrotechnical Society, with drawing of the socket and fastening. 1000 w. Elektrotech Zeitschr—May 11, 1899. No. 28352 B.

MEASUREMENT.

Alternating Currents.

Methods of Determining the Frequency of Alternating Currents. Carl Kinsley. Reviews methods that have been used and suggests a new and easy method that may be employed with an error of less than $\frac{1}{4}$ of 1 per cent. Ill. 1800 w. Elect'n, Lond—June 16, 1899. No. 28251 A.

Dynamo Testing.

A Simple Method of Testing Dynamos (Ueber eine Einfache Methode zur Prüfung von Dynamomaschinen). J. Fischer-Hinnen. Giving equations to be used in computing the losses due to friction hysteresis, and eddy currents. 2000 w. Elektrotech Zeitschr—June 1, 1899. No. 28361 B.

Galvanometers.

M. Blondel's Oscillographs. Abstract of a paper read before L'Association Francaise pour L'Avancement des Sciences. Discusses the principles of construction and the theory of this class of galvanometers with which the forms of the periodic curves of alternating currents may be observed. 1700 w. Elec Rev, Lond—June 16, 1899. No. 28247 A.

High Potentials.

Some Methods of Measuring High Potentials with Low Potential Instruments. Samuel J. Barnett. Illustrates and describes two methods found to be useful. 900 w. Elec Wld & Elec Engr—June 17, 1899. No. 28122.

Insulation.

The Measurement of the Total Insulation of Accumulator Batteries. (Methode zur Messung der Gesamtisolation von Akkumulatoren Batterien). C. Liebenow. Two methods are given, one for ordinary use and the other when a high degree of insulation is required. A brief discussion is appended. 2000 w. Elektrotech Zeitschr—May 18, 1899. No. 28357 B.

Insulation Meter for Alternating Currents (Isolationsmesser für Wechselstrom-Betriebsspannung). Dr. Gustav Benischke. Illustrating and describing the convenient portable apparatus of the

Allgemeine Elektrizitäts Gesellschaft, and giving examples of its use. 2500 w. Elektrotech Zeitschr—June 8, 1899. No. 28363 B.

Meter.

Improved Electric Power Meter (Nouveau Compteur d'Energie Electrique). M. Aliamet. An illustrated description of the new Aron meter, with automatic electric regulator. Details of the mechanism are given. 2500 w. L'Electricien—June 3, 10, 1899. No. 28373 each B.

Some Non-Integrating Electric Meters. William Edward Ayrton. Read before the British Inst. of Civ. Engrs. Considers the construction of meters, the materials used, improvements in galvanometers, ammeters, voltmeters, etc. Short discussion. 2000 w. Elec Eng, Lond—June 9, 1899. No. 28169 A.

Tests.

Transformer Tests. W. Elwell Goldborough. Abstract of a paper read before the Nat. Elec. Lgt. Assn., New York. Reports the results of a series of tests made at the electrical laboratories of Purdue University. Five different transformers were tested with gratifying results. 3700 w. Eng News—June 1, 1899. No. 27932.

POWER APPLICATIONS.

Electric Locomotives.

Electric Locomotive Design. Editorial discussion of the paper of P. V. McMahon, read before the London Inst. of Engrs., London. 1700 w. Engng—May 26, 1899. No. 28000 A.

Electric Locomotives in Practice and Tractive Resistance in Tunnels. An Abridgment of a paper by P. V. McMahon, read before the London Inst. of Elec. Engrs. It is based on experiments made on the locomotives and trains of the City & South London Ry. 4700 w. St Ry Jour—June, 1899. No. 27953 D.

Electric Power.

See Mining & Metallurgy, Mining.

Electric Vehicles.

See Mechanical Engineering. Automobilmism.

Machine Driving.

The Application of Electric Motors to Machine Driving. Andrew Stewart. Part first considers the commercial possibilities of electric power. 900 w. Elec, Lond—June 2, 1899. Serial. 1st part. No. 28079 A.

Mining Power.

Electric Transmission and Electric Drills for Mines. F. Hille. Read before the Can. Min. Inst. Discusses long-distance transmission, the production of

electricity by some other medium than water and directly at the mines, the application to machine driving, and the advantage of the electric drill. Ill. 4000 w. Can Min Rev—May 31, 1899. No. 27-987 B.

Propulsion.

Electrical Propulsion for Torpedo Boats. W. F. Durand. Discusses the limitations and possibilities of electric propulsion, in connection with a review of data given in an article by C. T. Child, published recently in the Jour. of Am. Soc. of Nav. Engs. 4300 w. Sib Jour of Engng—June, 1899. No. 28130 C.

Subdivision.

The Limitations of Power Subdivision by Electric Motors in Manufacturing Establishments. A topical discussion considering economy of power, economy of cost, convenience, etc. 16800 w. Trans Am Inst of Elec Engs—April, 1899. No. 28285 D.

TRANSMISSION.

Kootenay.

The Kootenay-Rossland Power Transmission. George P. Low. Illustrated description of the region, the power development, and pole line, are given in part first. 3700 w. Jour of Elec—May, 1899. Serial. 1st part. No. 28236.

Long Distance.

Economical Transmission and Distribution of Electricity from a Distance. Horace Field Parshall. Read before the British Inst. of Civ. Engs. Considers the subject under economical generation, transmission and distribution. Short discussion. 2200 w. Elec Eng, Lond—June 9, 1899. No. 28172 A.

Polyphase.

Rotary Transformers and Storage Batteries as Related to Long-Distance Transmission. William Lispenard Robb. Read before the Nat. Elec. Lgt. Assn., New York. A description of the Hartford, Conn., plant and of its operation. Discussion. 3800 w. Elec, N. Y.—May 31, 1899. No. 27908.

Polyphase.

Relation Between Armature and Line Currents in Polyphase Transmission.

Henry S. Carhart. Gives a graphical method for elucidating the relative phases and magnitudes of the currents flowing in adjacent connected circuits of a polyphase generator and in the line when the system is balanced. 800 w. Elec Wld & Elec Engr—June 17, 1899. No. 28121.

Three-Phase Power Transmission at St. Hyacinthe, Quebec, Canada. E. M. Archibald. Illustrated description of the oldest plant in Canada employing this system. 2200 w. Elec Wld & Elec Engr—June 24, 1899. No. 28216.

See Street and Electric Tramways.

MISCELLANY.

Insulation.

The Decay of Vulcanized Rubber. H. L. Terry. Discusses the cause of the decay, suggesting that it is the action of either the free or the combined sulphur in the copper. 2700 w. Elect'n, Lond—May 26, 1899. No. 27998 A.

"New" Rays.

Becquerel or Uranium Rays and Other "New" Rays and Their Relation to X-Rays. O. M. Stewart. An account of experimental work and the results. 1600 w. Sib Jour of Engng—June, 1899. No. 28134 C.

Rays.

Human Rays. Ottokar Hoffmann. An illustrated account of experiments seeming to show that the human body emits rays which act on a sensitive photographic plate. 1300 w. Eng & Min Jour—June 24, 1899. No. 28224.

Switzerland.

Electro-technical Excursion in Switzerland (Excursion Electrotechnique en Suisse). E. Herbet. An account of a visit made by the pupils of the Ecole Supérieure d'Electricité to the various hydraulic and electric plants in Switzerland, giving interesting data. 4000 w. Le Génie Civil—June 3, 1899. No. 28305 D.

X-Rays.

A Large Static Machine for X-Ray Work. Francis H. Williams. Illustrated description of a machine used for examinations in diseases of the chest, also the method. 1600 w. Sci Am—June 17, 1899. No. 28109.

GAS ENGINEERING

Acetylene.

Acetylene Safer Than Most Other Illuminants. H. F. Fuller. States facts to prove its safety especially from an insurance point of view. 1000 w. Dom Engng—June, 1899. No. 28199 C.

The Acetylene Plant for Lighting the Town of Schönsee (Die Acetylen-

Centrale für die Beleuchtung von Schönsee). Paul Wolff. A detailed description of this small municipal plant of 1,000 burners capacity, showing the arrangement of generators, purifiers and distribution. 5000 w. Glaser's Annalen—June 1, 1899. No. 28348 D.

The Use of Acetylene. Edward Ren-

ouf. Gives a review of the progress of this illuminant during the last five years, and predicts that acetylene will soon be a factor in giving an improved and cheaper light. Ill. 5200 w. *Ap Pop Sci M*—July, 1899. No. 28221 D.

By-Products.

Notes on the Recovery of Residual Products from Coal Gas During the Process of Purification. W. Foulis. Read before the Conference of the British Inst. of Civ. Engs. Brief presentation of methods in use, with discussion. 7000 w. *Jour Gas Lgt*—June 13, 1899. No. 28192 A.

Coke Ovens.

The By-Product Coke Oven for the Manufacture of Illuminating Gas. Henry W. True. Reports the manufacture of illuminating gas in a block of 10 by-product coke ovens at Halifax, N. S. 2000 w. *Am Gas Lgt Jour*—June 5, 1899. No. 27959.

Explosion.

Chlorate of Potash. Editorial on points connected with the explosion at St. Helens. 1400 w. *Engng*—May 26, 1899. No. 28001 A.

The Destruction of the St. Helens Gas-holder. Illustrated account showing the amount of damage. 900 w. *Jour Gas Lgt*—May 23, 1899. No. 27937 A.

Fuel Gas.

Dr. Lawson Tait on the Uses of Gas for Fuel. A critical examination of the hints and suggestions presented in a recent lecture advocating gas-heating. 2400 w. *Jour Gas Lgt*—June 13, 1899. No. 28191 A.

Fittings.

The Extension of Gas Companies' Responsibility to Fittings Beyond the Meter. Frank A. Winstanley. Read before the Incorporated Gas Inst., England. Advocates the extension of the gas manager's control to all appliances necessary for the efficient use of gas. 3000 w. *Gas Wld*—June 17, 1899. No. 28283 A.

Furnace Gas.

Further Progress in the Application of Blast Furnace Power Gas. (Weitere Fortschritte in der Verwendung von Hochofenkraftgas). F. W. Lürmann. A paper before the *Verein Deutscher Eisenhüttenleute*, giving very full computations as to the mechanical and commercial economy to be expected in the use of furnace gases for motive power. Also discussion. Two articles. 15000 w. *Stahl und Eisen*—May 15, June 1, 1899. No. 28338 each D.

The Utilization of Furnace Gas for Power. A record of European work in

this field is commenced. Part first gives abstract of papers by Enrique Disdier and by Fritz W. Lürmann. 2200 w. *Ir Age*—June 29, 1899. Serial. 1st part. No. 28293.

Gas Engines.

See Mechanical Engineering, Special Motors.

Gas Power.

See Mechanical Engineering, Special Motors.

Hydraulic Main.

The Evolution of the Hydraulic Main. William Carr. Read before the Incorporated Gas Inst., England. Shows how the hydraulic main was made to serve its purpose in the early days of its use, and reviews the improvements made necessary by changed conditions. Discussion. Ill. 11500 w. *Gas Wld*—June 17, 1899. No. 28277 A.

Labor Saving.

Labor-Saving Appliances in Gas Works. C. C. Carpenter. Read before the Conference of the British Inst. of Civ. Engs. Considers the practice of the South Metropolitan Gas-Works, of London. Discussion. 6500 w. *Jour Gas Lgt*—June 13, 1899. No. 28193 A.

Liquors.

An Examination of Gas Liquors. Inquiries made to measure the scrubbing and washing efficiency and also to ascertain the distribution of the sulphur. 2500 w. *Gas Wld*—June 10, 1899. No. 28179 A.

Naphthalene.

Naphthalene Deposits; Their Cause and Prevention. John P. Leather. Read before the Incorporated Gas Inst., England. Discusses the subject and the remedy most favored by the author. Discussion. 6500 w. *Gas Wld*—June 17, 1899. No. 28278 A.

The Causes Underlying the Formation of Naphthalene and Their Prevention. Paul Doty. Reviews papers and investigations recently reported from Europe, and gives personal experiences. 5000 w. *Am Gas Lgt Jour*—June 26, 1899. No. 28238.

Natural Gas.

I. Cincinnati Natural Gas Investigation. II. Natural Gas Supply. The first article gives the principal provisions of the Laidlaw Ordinance and the discussion. The second is the testimony of Edward Orton, the State geologist. 5500 w. *Pro Age*—June 15, 1899. No. 28143.

Piping.

Gas Piping Topics. Considers incrustation and scale, means of prevention, set

screws, hardening, cutting threads on gas pipes, keeping worn screws in service, double nut, tools, leaks, etc. Ill. 2200 w. Am Gas Lgt Jour—June 12, 1899. No. 28050.

Rare Earths.

On the Luminosity of the Rare Earths When Heated "in vacuo" by means of Cathode Rays. A. A. Campbell Swinton. Describes investigations of the writer of the comparative luminosity of different mixtures of the rare earths. 2000 w. Elec Rev, Lond—June 2, 1899. No. 28084 A.

Rates.

Differential Rates as Between Consumers of Gas for Lighting and for Purposes Other Than Lighting. Thomas Newbigging. Read before the Incorporated Gas Inst., England. Discusses the practice of gas companies in the United Kingdom, which seems to be unfair to customers who use gas only for lighting. Discussion. 11000 w. Gas Wld—June 17, 1899. No. 28275 A.

Regenerative System.

The Advantages of the Regenerative System for Small Gas Works. John Lyne. Read before the Incorporated Gas Inst., England. An account, based upon the author's experience at Wexford, of the benefit resulting from the adoption of this system. Discussion. 5300 w. Gas Wld—June 17, 1899. No. 28282 A.

Retorts.

Recent Experience in Working Inclined

Retorts. Charles A. Craven. Read before the Incorporated Gas Inst., England. Gives reasons why this system is favored by the author, describing the experience at the Dewsbury works during 1898. Discussion. 8500 w. Gas Wld—June 17, 1899. No. 28279 A.

Self-Kindling.

Self-Kindling by Chemical Means. Extract from an article in the *Journal für Gasbeleuchtung* on "Self-Kindling of Lighting Gas," by Dr. C. Killing. Considers the modern forms, or those used since the beginning of the century, and especially since the eighties. 800 w. Gas Wld—May 27, 1899. No. 27997 A.

Water Gas.

Carburetted Water Gas, with Reference to the Recent Report of the Departmental Committee. A. G. Glasgow. Read before the Incorporated Gas Inst., England. A discussion of the subject from the gas-makers' side. 8400 w. Gas Wld—June 17, 1899. No. 28276 A.

The Influence of Carbonic Acid on the Combustion of Coal and Carburetted Water Gas. Frederick G. Dexter. Read before the Incorporated Gas Inst., England. Gives valuable information as to the effect of carbonic acid in depreciating the illuminating and calorific values. Usually, the purer the quality of the gas the greater the injury to the illuminating value. Discussion. 3500 w. Gas Wld—June 17, 1899. No. 28281 A.

MARINE AND NAVAL ENGINEERING

MARINE AND NAVAL ENGINEERING.

Armor.

Recent Trials of Cemented Steel Armor Plates (Essais Récents de Plaques en Acier Cémenté). L. Baclé. A discussion of recent trials on hardened armor plates, with tabulated data and results from tests made in England, America, Russia and other countries. Two articles. 4000 w. Le Génie Civil—May 20, 27, 1899. No. 28302 each D.

Argonaut.

Trials and Experiments Made in H. M. S. Argonaut. John Durston. Read before the Inst. of Naval Archts. An account of the results of the contract trials and experiments made while these were being carried out. Ill. 3200 w. Jour Am Soc of Nav Engs—May, 1899. No. 27991 H.

Beams.

See Mechanical Engineering, Materials.

Cargo Steamers.

Recent Developments in Cargo Steam-

ers. Edward William de Russett. Read before the Engineering Conference of the Inst. of Civ. Engs., England. General notes on British steamers, considering type, size, construction, capacity, cargo, appliances, ballasting, economy of working. 2200 w. Engng—June 16, 1899. No. 28273 A.

Castle Liners.

The Kinfauns Castle. Describes and illustrates one of the new steamers of the Castle Mail Packets Co., Limited, which will be used in the Cape trade. 2800 w. Engr, Lond—May 19, 1899. No. 27903 A.

Compressed Air.

Compressed Air to Save Ships. Frank Richards. Suggesting the use of air compressors to save the steamship "Paris," and for universal service in like emergencies. 1200 w. Am Mach—June 1, 1899. No. 27935.

Cruiser.

The French Armored Cruiser Jeanne

D'Arc. Details of this vessel, with illustration; also very severe criticism, comparing her with the British vessels, the "Powerful" and "Diadem." 1500 w. Engr, Lond—June 9, 1899. No. 28187 A.

The Trials of H. M. S. "Hermes." An account of the interesting series of steam trials just completed, which gave important data bearing upon high steam pressures. 1800 w. Engng—June 9, 1899. No. 28181 A.

Express Boilers.

Express Boilers in War Vessels. Information concerning the number of vessels being fitted with boilers of the Yarrow type, especially by the Dutch Government. 1500 w. Engr, Lond—May 26, 1899. No. 28010 A.

Loading.

The Discharging and Reloading of Large Steamers. William Henry Hunter. Read before the Engineering Conference of the British Inst. of Civ. Eng. Describes briefly the methods of working now in use at the Manchester docks of the Manchester Ship Canal. 2000 w. Engng—June 9, 1899. No. 28182 A.

Merchant Marine.

Merchant Steamers and War Requirements. John Harvard Biles. Read before the Engng. Conference of the British Inst. of Civ. Eng. On the practicability of so constructing merchant steamers as to render them readily available for war purposes. 1000 w. Engng—June 9, 1899. No. 28185 A.

Sea-Power and Sea-Carriage. Benjamin Taylor. An examination of the present extent and conditions of the world's sea-carrying trade, considering the actual shipping of each country, especially the share of Great Britain. 7200 w. Nineteenth Cent—June, 1899. No. 28155 D.

The Need of an American Merchant Marine. Alex. R. Smith. Read at meeting of the Trans-Mississippi Commercial Congress. Introductory to a discussion of the importance of restoring American ships to the foreign carrying trade. 1400 w. Naut Gaz—June 15, 1899. Serial. 1st part. No. 28137.

Passenger Steamers.

Swift Passenger Steamers of Moderate Size. Edwin Lewis Martin. Read before the Engng. Conference of the British Inst. of Civ. Eng. Briefly suggests important considerations which affect the speed, safety and comfort of such vessels. 1200 w. Engng—June 9, 1899. No. 28184 A.

Propulsion.

See Electrical Engineering, Power Applications.

Repair Ship.

The Work of the Naval Repair Ship Vulcan. Gardiner C. Sims and W. S. Aldrich. A noteworthy account of the attempts to raise the sunken Spanish wrecks, and the true story of the loss of the Maria Teresa. 6000 w. Engineering Magazine—July, 1899. No. 28382 B.

Shipbuilding.

Shipbuilding and Shipping Conditions of the United States—Past, Present and Future. George R. M'Dermott. Reviews the conditions of the mercantile marine and the coasting service, discussing also the future of the foreign trade, and the industry of shipbuilding. 2700 w. Marine Engng—June, 1899. No. 28015 C.

COMMUNICATION.

Steam Navigation.

Reminiscences of Early Marine Steam Engine Construction and Steam Navigation in the United States of America, from 1807 to 1850. (Continued.) Chas. H. Haswell. A continuation of a former paper in order to make the record as complete as possible. 1400 w. Jour Am Soc of Nav Engs—May, 1899. No. 27992 H.

Steamship Performance.

Steamship Performances Compared. J. D. M'Arthur. Abstract of a paper read before the Inst. of Marine Engs., England. Gives the loading dimensions and particulars of the vessels, and the comparative results of their working. 1200 w. Steamship—June, 1899. No. 28081 A.

Steam Yacht.

Full-Powered Sea-Going Steam Yacht Aphrodite for Col. Oliver H. Payne, of New York. William A. Fairburn. Gives details of construction and equipment and report of speed tests. Ill. 3200 w. Marine Engng—June, 1899. No. 28016 C.

Submarine.

Submarine Boats. Lawrence Irwell. A summary of the efforts that have been made during three centuries to build ships for service. 3000 w. Marine Rev—June 1, 1899. No. 27958.

The Progress of Submarine Navigation. Illustrated historical review of all notable plans of submarine boats that have been designed. 1200 w. Sci Am Sup—June 3, 1899. Serial. 1st part. No. 27942.

Torpedo Boat.

Launch of the Stringham. Describes the launch of the largest torpedo boat built or building for the United States Navy; giving also brief accounts of other vessels at the Wilmington, Del., works. 900 w. Marine Rev—June 15, 1899. No. 28152.

Warship Machinery.

Recent Trials of the Machinery of Brit-

ish Warships. Albert John Durston and Henry John Oram. An account of the recent extensive developments in marine engineering practice in the Royal Navy, with record of particulars and results obtained from the machinery of warships. 6500 w. Jour Am Soc of Nav Engs—May, 1899. No. 27989 H.

Water Tubes.

The Water-Tube Boiler in Passenger Steamers. The application of this type of boiler to the Lorna Doone, a pleasure steamer. 1500 w. Engr, Lond—May 26, 1899. No. 28011 A.

Water-Tube Boilers, S. S. Orlando. A report recently issued by the British Board of Trade showing this type of

boiler quite unsuited for use with sea water. Also editorial discussing the constructional failures of these boilers. 4000 w. Engr, Lond—June 9, 1899. No. 28186 A.

Yacht Plumbing.

Novel Yacht Plumbing. Illustrates and describes the sanitary arrangements in the new steam yacht "Neaira." 1200 w. Met Work—June 17, 1899. No. 28136.

Yacht.

The Lines and Construction of the Yacht "Columbia." Drawings and description. 1400 w. Sci Am—June 24, 1899. No. 28201.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Electric Vehicles.

Electric Automobiles (Les Automobiles Electriques). M. Schmitt. A general review of the applicability of electric driving for automobile vehicles, and a comparison of costs with animal power. Three articles. 3000 w. L'Electricien—May 6, 27; June 3, 1899. No. 28370 each B.

Waverly Electric Runabout and Columbia Electric Emergency Wagon. Illustrated descriptions of two electric vehicles, exhibited at the recent exhibition in Madison Square Garden, N. Y. 900 w. Sci Am—June 10, 1899. No. 28034.

Bremerhaven.

Electric Tramways and Automobiles in Bremerhaven (Elektrische Strassenbahn in Bremerhaven und Elektrische Automobilen). Dr. Sieg. Discussing mainly the use of storage batteries both for tramway and automobile service. 5000 w. Elektrotech Zeitschr—May 11, 1899. No. 28354 B.

Long Distance.

A Remarkable Automobile Trip. An account of the trip of a Winton motor carriage from Cleveland, O., to New York, a distance of 707.4 miles, being accomplished in 47 hours 29 minutes. 1000 w. Can Engr—June, 1899. No. 28058.

Paris Trials.

Motor Cab Trials in Paris. An account of the trials with description of the vehicles entered. 3500 w. Engr, Lond—June 16, 1899. No. 28260 A.

Road Vehicles.

A Study of Mechanical Traction on Roads (Etude d'une Voiture à Traction Mécanique sur Routes). G. Forestier. A discussion of the conditions of heavy

haulage on roads and in city streets, with reference to the design of motor trucks for such service. Serial. Part 1. 5000 w. Le Génie Civil—May 27, 1899. No. 28303 D.

Electric Road Vehicles (Ueber Elektrische Fahrzeuge). Franz Wilking. With numerous illustrations of automobile omnibuses, coaches, cabs, etc. 4000 w. Elektrotech Zeitschr—May 25, 1899. No. 28358 B.

Road Wagons and Motors. Hugh Dolnar. A concise statement of the standing of the motorcycle motor. Ill. 2500 w. Am Mach—June 8, 1899. No. 28042.

HYDRAULICS.

Pump.

The Lemaire Pump (La Pompe Lemaire). An illustrated description of an improved form of chain pump of high efficiency, especially adapted for agricultural and colonial use. 1200 w. La Revue Technique—May 25, 1899. No. 28309 D.

Riveted Pipes.

The Joints of Riveted Water Pipes. Emil Kuichling. Abstract of an address before the students of Rensselaer Polytechnic Inst. on the design of riveted steel pipe. 3000 w. Eng Rec—June 10, 1899. No. 28077.

Turbines.

The Blades of the Francis Turbine (Ueber Francis-Turbinenschaufelung). Speidel & Wagenbach. A discussion of the proper curvature of the blades of turbines of the Francis pattern, with geometrical method for laying out. 2500 w. Zeitschr d Ver Deutscher Ing—May 20, 1899. No. 28317 D.

Turbine Installation at Strensham Mills. Describes the successful utilization

of a water-power having a fall of only 2 feet. Ill. 1700 w. Engng—June 2, 1899. No. 28091 A.

Valves.

The Flow of Water Through Valves. Illustrated report of experiments made by Prof. William T. Magruder at the Ohio State University to determine the influence of various types of valves on the discharge of pipes. 2300 w. Eng Rec—June 24, 1899. No. 28234.

MACHINE WORKS AND FOUNDRIES.

Ball Bearings.

The Theory and Construction of Ball Bearings. W. H. Hale. Considers the principles of ball bearings and the improvements needed to make them practical and successful. Ill. 2400 w. Sci Am—July 1, 1899. No. 28295.

Castings.

Fillets and Round Corners on Modern Machinery Castings. John M. Richardson. Discusses the value of the fillet in patterns, advantages in the finished casting, and fillets in core work. 2400 w. Ir Trd Rev—June 15, 1899. No. 28138.

Charges.

Shop and General Establishment Charges in Engineering Works and Their Relation to Costs and Estimates. William Edward Cowens. Read before the Brit. Inst. of Engs. and Shipbuilders. Illustrates the method of dealing with these charges. 2200 w. Engs' Gaz—June, 1899. No. 28035 A.

Cone Pulleys.

The Computation of Cone Pulleys (Zur Berechnung des Stufenscheiben-Antriebes). Heinrich Weiss. A development of a graphical method for designing cone pulleys for machine tools for any given series of speeds. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—May 26, 1899. No. 28330 B.

Foundries.

Modern Foundry Buildings. Armin Schotte. Read at the meeting of the Pittsburg Foundry Men's Assn. Considers the best construction to fulfill the conditions required, and recommends the "cementine" as the ideal construction. 2200 w. Ir Trd Rev—June 1, 1899. No. 27936.

Hoisting.

Design of Hoisting Drums for Uniform Torque. John H. Barr. Considers method of determining the curve of a uniform torque drum, discussing other types in use. 1600 w. Sib Jour of Engng—June, 1899. No. 28127 C.

Machine Driving.

See Electrical Engineering, Power.

Molding.

Molding a Corliss Engine Pillow Block. R. H. Palmer. Illustrated detailed description. 1300 w. Am Mach—June 29, 1899. No. 28294.

Molding a Drop Press Bed. R. H. Palmer. Illustrated detailed description. 1200 w. Am Mach—June 8, 1899. No. 28043.

Ornamental Iron.

The Use, Design and Manufacture of Iron in Ornament. Chester B. Albree. Full paper. Discusses ancient and modern work, describing processes of manufacture, and showing the importance of architects and engineers studying how to use this material effectively. Ill. 6000 w. Pro Engs' Soc of W. Penna—March, 1899. No. 28047 D.

Screw Machine.

An Automatic Screw Machine. Illustrates and describes the appearance and construction of a recently perfected machine. 1700 w. Am Mach—June 8, 1899. No. 28041.

Slot Machines.

Coin-Controlled Machinery. Arthur F. Wines. Considers the design of these machines and the defects to be guarded against. Also the application of the mechanism to the automatic telephone. Ill. 1500 w. Sib Jour of Engng—June, 1899. No. 28129 C.

Tools.

Case-Hardening and Annealing. Fred. H. Colvin. Reviews the methods used in small shops. 1500 w. Loc Engng—June, 1899. No. 27906 C.

Works Management.

Machine-Shop Management in Europe and America. H. F. L. Orcutt. A detailed examination of the elements of a modern machine shop, giving the author's conception of the best method of organization and subdivision. 3000 w. Engineering Magazine—July, 1899. No. 28383 B.

MATERIALS OF CONSTRUCTION.

Beams.

Bending Stresses in Z-Beams in Ship-Construction (Die Biegungsspannungen der Z-Eisen zu Schiffbauzwecken). A. Meyerhof. A graphical study of the bending stresses, with very complete tables of the moments of resistance for various sections. 6000 w. Zeitschr d Verscher Ing—May 27, 1899. No. 28319 D.

Bronzes.

A Study of the Micro-Structure of Bronzes. E. Heyn. A contribution to the subject of metallography, with a criticism of A. E. Outerbridge's paper.

Ill. 5000 w. Jour Fr Inst—June, 1899. No. 27980 D.

Copper Alloys.

The Endurance of the Ordinary Copper Alloys in Sea Water. Herr Diegel. Abstract translation of an article in *Marine-Rundschau*. An account of experiments made on sheathing for vessels, describing tests and giving results. 8500 w. Jour Am Soc of Nav Engs—May, 1899. No. 27990 H.

Crucible Steel.

The Crucible Steel Works of J. Braun's Sons at Schloss Schöndorf (Die Tiegel-Gusstahlfabrik von J. Braun's Söhnen in Schloss Schöndorf). With plans of the furnaces and illustrations of armor-plate products. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Huttenwesen—May 27, 1899. No. 28345 B.

Low Temperatures.

The Effect of Low Temperatures upon Certain Steels (De l'Effet des Basses Températures sur Certains Aciers). F. Osmond. Discussing experiments made upon steel cooled with liquid air, especially with regard to its magnetic properties. 1000 w. Comptes Rendus—June 5, 1899. No. 28316 D.

Steel Castings.

Experiments on the Elasticity, Tensile Strength and Elongation of Steel Castings (Versuche über Elastizität, Zugfestigkeit Dehnung und Arbeitsvermögen von Stahlguss). C. Bach. With tabulated results of tests at various temperatures. 1500 w. Zeitschr d Ver Deutsch-er Ing—June 10, 1899. No. 28324 D.

POWER AND TRANSMISSION.

Belts.

Power Consumed by Shafting and Belts. C. H. Benjamin. An account of experiments made by senior students of Case School of Applied Sciences under the direction of the writer. 1200 w. Ir Trd Rev—June 8, 1899. No. 28039.

Conveyors.

Coal Conveyors. Extract from paper by Charles Piez, Philadelphia. Considers bucket conveyors, link-belt conveyors and the scraper conveyor. 2000 w. Gas Wld—June 3, 1899. No. 28082 A.

Handling Minerals.

Economy in Handling and Transport of Minerals. Charles de Neuville Forman. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Calls attention to the importance of this subject, offering suggestions. 1200 w. Col Guard—June 16, 1899. No. 28263 A.

How Ore Is Handled. Illustrates and describes the ore-handling machinery and methods used at Conneaut, Ohio, on

Lake Erie. 2800 w. Marine Rev—June 22, 1898. No. 28237.

SPECIAL MOTORS.

Air Motors.

Compressed Air Motors in New York. An illustrated detailed description of the air-power system as in use in New York, which differs in many respects from that used in Europe. 3500 w. St Ry Jour—June, 1899. No. 27952 D.

Gas Engines.

Gas Engines: The Number in Use and Their Applications. Bryan Donkin. A summary of information obtained by sending circulars to the gas companies of the United Kingdom. 1000 w. Jour Gas Lgt—May 30, 1899. No. 28045 A.

The Evolution and Future of the Gas Engine. Georg Lieckfeld. A review of the historical development of the internal combustion motor, showing the lines along which its future successful development may be expected. 3500 w. Engineering Magazine—July, 1899. No. 28388 B.

Gas Power.

Gas for Motor Purposes. T. Ormiston Paterson. Read before the Incorporated Gas Inst., England. The author believes that gas has a great future awaiting it in this field. Gives data obtained by experiments with different gases and information bearing upon this subject. Discussion. 1000 w. Gas Wld—June 17, 1899. No. 28280 A.

Oil Engines.

The Commercial Advantage of the Oil Engine. John A. Secor. Considers the use of kerosene as a fuel in internal combustion motors, its thermodynamic value, price, features of the oil motor, etc. 1800 w. Mach, N. Y.—June, 1899. No. 27928.

Petroleum.

Petroleum Motors (Ueber Motorbetrieb mit Erdölen). Ludwig Loos. A review of the development of petroleum motors, and a comparison of the fuel consumption of various types. 2500 w. Zeitschr d Oesterr Ing u Arch Ver—June 16, 1899. No. 28333 B.

STEAM ENGINEERING.

Boiler Accident.

A Peculiar Boiler Accident—Result of a Vacuum. From the British *Shipping Gazette*. An accident on the British steamer "Elderslie" is described, which caused the death of the third engineer in a most unusual manner. 900 w. Am Mach—June 15, 1899. No. 28101.

Boiler Installation.

The Installation of Steam Boilers.

Critical discussion of details of boilers and their surroundings, with a view to showing the causes of present practice. 1500 w. *Elec Rev*, Lond—June 16, 1899. Serial. 1st part. No. 28248 A.

Boilers.

The Computation of Steam Boilers (*Berechnung der Dampfkessel*). E. Brauss. A discussion of the proper dimensions of a boiler for a steam-heating system, taking into account various fuels. Data concerning chimneys are also given. 2000 w. *Gesundheits-Ingenieur*—May 15, 1899. No. 28335 B.

Boiler Test.

Test of a Babcock & Wilcox Boiler Built for the Alert. Gives the general dimensions of the boilers, pointing out wherein they differ from others heretofore built for vessels of the U. S. Navy, and describes the tests made. 4800 w. *Jour Am Soc of Nav Engs*—May, 1899. No. 27988 H.

Condensing.

Central Steam Condensing Plants. From *Stahl und Eisen*. Calls attention to the advantages, and reasons for rapid development of this new branch of steam engineering; and gives an illustrated detailed description of such a plant. 3800 w. *Ir & Coal Trds Rev*—June 16, 1899. No. 28284 A.

The Central Condensing Plant of the Recklinghausen Mine (*Die Central Kondensation des Schachtes Recklinghausen*). With detailed description of this large surface condensing plant and a record of its performance over a period of six months. 2500 w. *Glückauf*—June 3, 1899. No. 28342 B.

Connecting Rods.

On the Connecting-Rod Problem. Prof. Dunkerley. Gives the solution to four stated problems, considering simply the effect of the inertia of the rod. 4700 w. *Engng*—June 2, 1899. No. 28090 A.

Efficiency.

The Efficiencies of Steam Boilers and Furnaces. R. S. Hale. An examination of the conditions upon which boiler and furnace efficiency depend, based upon a comparative study of a large number of tests. 3500 w. *Engineering Magazine*—July, 1899. No. 28385 B.

Engines.

German Rolling Mill Engines. C. Kiesselbach. Abstract of a paper read before the *Verein Deutscher Eisen Huettenleute*. An illustrated review of recent development in this class of engines, discussing the general points of compound in engines in this first part. 3500 w. *Ir Age*—June 8, 1899. Serial. 1st part. No. 28029.

Rolling Mill Engines (*Die Motoren zum Antrieb der Walzenstrassen*). C. Kiesselbach. A paper read before the *Verein Deutscher Eisenhuettenleute*, giving a very detailed account of German practice, with many illustrations. The discussion is appended. Two articles, 10 plates, 15000 w. *Stahl und Eisen*—May 1, 15, 1899. No. 28336 each D.

Explosion.

Boiler Explosion in a Brewery. Illustrates and describes a recent boiler explosion at the plant of the Standard Brewing Co., Rochester, N. Y. 1000 w. *Locomotive*—June, 1899. No. 28274.

Express Boilers.

See Marine and Naval Engineering.

Furnaces.

Furnace Fittings. Part first discusses furnace casing, and cold-air supply and connections. 2000 w. *Met Work*—June 3, 1899. Serial. 1st part. No. 27945.

The Heckmann Furnace (*Die Heckmann Feuerung*). H. Blezinger. Describing and illustrating an improved form of regenerative furnace, adapted both for steam boilers and for metallurgical purposes. 2500 w. *Zeitschr d Ver Deutscher Ing*—June 17, 1899. No. 28327 D.

Governor.

The American Inertia Governor (*Die Amerikanischen "Inertie" Regulatoren*). A. Stodola. A general discussion of shaft governors of the inertia type, with illustrations from recent American practice. 2000 w. *Schweizerische Bauzeitung*—May 20, 1899. No. 28350 E.

High Speed.

Quick Revolution Steam Engines. Arthur Herschmann. Historic review of the evolution of quick-revolving engines, considering the present practice and discussing the merits of a few types. Ill. 6000 w. *Pro Engs' Soc of W. Penna*—April, 1899. No. 28048 D.

Mechanical Draft.

The Influence of Mechanical Draft Upon the Ultimate Efficiency of Steam Boilers. Walter B. Snow. Describes the apparatus employed in the production of mechanical draft, shows the economy in first cost in part first. Ill. 1900 w. *Heat & Ven*—June, 1899. Serial. 1st part. No. 28290.

Pressure.

Something About Pressure. W. H. Wakeman. Gives a list of various pressures, showing how some of them are misplaced, and gives directions for calculating different pressures. 2800 w. *Engr, U. S. A.*—June 1, 1899. No. 27985.

Regulator.

The Sandillon Pressure Regulator (Detendeur Regulateur de Pression, Systeme Sandillon). J. Loubat. With reports of trials both of the pressure regulator and of an automatic boiler feeder of similar design. 2000 w. *La Revue Technique*—June 10, 1899. No. 28311 D

Superheating.

Improvements in the Use of Steam (Veredelung des Wasserdampfes). A. Hering. A discussion of the economy effected by superheating, with illustrations of superheaters and data of tests 5000 w. *Zeitschr d Ver Deutscher Ing*—June 10, 1899. No. 28325 D.

Thermodynamic Action of "Steam-Gas." R. H. Thurston. On the valuable paper by Prof. Sinigaglia, published in the *Revue de Mecanique*. 1100 w. *Sib Jour of Engng*—June, 1899. No. 28128 C.

The Application of Superheated Steam to the Driving of Steam Engines (Die Anwendung Ueberhitzten Dampfes zum Betriebe von Dampfmaschinen). R. Doerfel. The beginning of an exhaustive study of the use of superheated steam; collecting and discussing tests. Serial. Part I. 6000 w. *Zeitschr d Ver Deutscher Ing*—May 27, 1899. No. 28318 D.

Traction Engines.

Electric Light and Traction Engines. The object of the article is to describe some specimens of the work of English engine-makers. Ill. 1700 w. *Elec Rev*, Lond—June 16, 1899. No. 28249 A.

Water Tubes.

See Marine and Naval Engineering.

Working Loads.

Investigation of the Actual Working Loads, Stresses, etc., on the Moving Parts of a Compound Non-Condensing Steam Engine. Q. E. D. Investigations of interest in showing the methods of determining the various stresses, etc. Describes the engine used. 1800 w. *Prac Engr*—May 26, 1899. Serial. 1st part. No. 27996 A.

MISCELLANY.**Air.**

Mixtures of Air and Watery Vapor. Frank Richards. Diagrams are given and explained, of interest in studying the problem of controlling the relative humidity of air by means of its artificial compression and expansion. 900 w. *Am. Mach*—June 22, 1899. No. 28196.

Air Compressor.

Mammoth Air Compressor for Street Railroad Motors. Illustrated description of the plant for supplying the air motors in the cars of the Metropolitan Street

Railway Co., New York. 1200 w. *Ir Age*—June 8, 1899. No. 28028.

Two Pipe Air Compression. Charles Cummings. A reply by the inventor to Mr. Chodzko's criticisms of the Cummings system. 2200 w. *Mod Mach*—June, 1899. No. 27984.

Artillery.

The Law of Pressure at the Muzzle of a Gun (Sur la Loi des Pressions dans les Bouches à Feu). M. Vallier. A communication to the French Academy discussing the distribution of pressures at various points in the barrel of a gun. 1200 w. *Comptes Rendus*—May 29, 1899. No. 28315 D.

Chronometer.

The Laws of the Variations in Amplitude of Chronometer Balances (Lois des Variations d'Amplitude du Balancier des Chronomètres). Marcel Brillouin. Describing the method of photographing continuously the vibrations of a balance wheel, enabling the variations to be recorded and studied. 10000 w. *Bull de la Soc d'Encorur*—May, 1899. No. 28314 G.

Compressed Air.

Compressed Air to Ring the Bells of St. Patrick's. Brief description of the mechanism being installed to ring this chime of nineteen bells. 700 w. *Am. Mach*—June 8, 1899. No. 28040.

See Marine and Naval Engineering.

Explosion.

The Toulon Explosion. J. T. Bucknill. An account of the great explosion on March 5 of two magazines, the cause still remaining a mystery. 2200 w. *Engng*—May 26, 1899. No. 27999 A.

Institution Home.

The Institution of Mechanical Engineers. A brief historical sketch of the British Society, with an illustrated description of the new building in London. 2800 w. *Engng*—May 19, 1899. No. 27900 A.

Liquid Air.

A Plant for the Commercial Manufacture of Liquid Air. Illustrates and describes a plant soon to be put in operation in New York, with an estimated capacity of about 1,500 gallons per day. 3000 w. *Eng News*—June 8, 1899. No. 28027.

Liquid Air and Explosives. Frederick H. McGahie. A discussion of the efforts being made to utilize liquid air in explosives, and the limited success thus far obtained. 2400 w. *Sci Am Sup*—June 3, 1899. No. 27944.

Liquid Air. W. Hampson, in *British Refrigeration*. Historical review of facts connected with this subject, with criticism of statements attributed to Mr.

Charles E. Tripler. 3500 w. Sci Am Sup—July 1, 1899. No. 28297.

Refrigeration.

Operating Ice Machines. W. H. Wake-Man. Practical suggestions to engineers in charge of ice or refrigerating machinery. Explains how a machine is rated and how to calculate capacity. 2700 w. Ice & Refrig—June, 1899. No. 27983 C.

Smoke.

On Smoke and Its Diminution. Bryan Donkin. Part first considers the need of

pressure to secure the prevention of smoke, its nature, combustion, determination, smoke scales, etc. 3000 w. Engr, Lond—May 26, 1899. Serial. 1st part. No. 28007 A.

Terra Cotta.

The Manufacture of Terra Cotta. Walter P. Rix. The object of the article is to point out some of the causes of failure and to suggest the best method of overcoming the obstacles. 3300 w. Brick—June 1, 1899. No. 28031.

MINING AND METALLURGY

COAL AND COKE.

Anthracite Mines.

Mining and Ventilating Anthracite Mines with Increasing Depths. H. O. Prytherich. Suggestions as to improved methods. 3000 w. Mines & Min—June, 1899. No. 27967 C.

Bituminous Coals.

Comparative Tests of Bituminous Steam Coals. John W. Hill. An account of valuable experimental work by the author on the various bituminous steam coals, to determine the most economical coal for steam purposes. Comparative results are given. 14000 w. Pro Am Soc of Civ Engs—April, 1899. No. 28110 E.

Briquettes.

Apparatus for Testing Pitch for Briquette Making. O. Binder, in *Oesterreichische Zeitschrift für Berg und Huttenwesen*. Describes apparatus and method of working by means of which the suitability of pitch for briquettes may be ascertained. 1100 w. Col Guard—June 16, 1899. No. 28267 A.

Cape Breton.

The Sydney Coalfield, Cape Breton. Harrison F. Bulman. An account of the collieries of the Dominion Coal Company and of the General Mining Association. 3800 w. Col Guard—June 2, 1899. No. 28092 A.

Coal Cutting.

Coal-Cutting Machinery from the Humanitarian Point of View. Ernest Kilburn Scott. A study of the subject, showing the superiority of machinery over hand labor, and the saving of life resulting from its adoption. 1000 w. Elec Rev, Lond—June 9, 1899. No. 28178 A.

Coal Transportation.

The Transport of Coal on the Ohio and the Lower Mississippi. James H. Bartlett. A description of transportation, overcoming difficulties due to the

intermittent character of the navigation, and the magnitude of the undertaking. 6500 w. Col Guard—June 2, 1899. No. 28095 A.

Coke Ovens.

By-Product Coke Ovens. Evence Copée. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Gives results obtained in the Copée recovery system. Discussion. 2500 w. Col Guard—June 16, 1899. No. 28264 A.

Fuel Analysis.

Examination and Analysis of Mineral Fuel by Roentgen Rays. Henry Couriot. From a communication to the Société de l'Industrie Minérale. Describes the method and apparatus used, and examination of specimens. 3700 w. Col Guard—May 26, 1899. No. 28006 A.

Kent, Eng.

The Kentish Coalfields. Explains the views of geologists which have led to a search for coal deposits, and describes the Dover workings. 3500 w. Engr, Lond—May 26, 1899. No. 28008 A.

Mining Improvements.

Modern Improvements in Coal Mining: Winding from Deep Mines. Henry William Martin. Read at the Engineering conference of the Inst. of Civ. Engs., England. Describes the main features of the winding machinery at a new colliery in South Wales. 2000 w. Engr, Lond—June 16, 1899. No. 28255 A.

Pittsburg.

Pittsburg, with Its Black Diamonds. A. P. Kirtland. An account of this city and its industries, all of which is attributed to the coal in that locality. Ill. 5800 w. Pro of Engs Soc of W Penna—May, 1899. No. 28286 D.

Silesia.

The Principal Coal Deposits of Upper Silesia (*Die Hauptstörung des Oberschlesischen Steinkohlenbeckens*). C. Gaebler. With an extensive map and

geological section and a review of the development of the region. 5000 w. Glückauf—May 27, 1899. No. 28341 B.

COPPER.

Copper.

Copper. Arthur Lakes. Describes its ores, their appearances and values, how they occur, and the peculiarities to be noticed. 1800 w. Mines & Min—June, 1899. No. 27964 C.

GOLD AND SILVER.

Alaska.

Gold Mining in Alaska: Notes from the Klondike. On the promising conditions of these fields, and interesting information relating to their development. 2300 w. U. S. Cons Repts, No. 447—June 9, 1899. No. 28049 D.

Bathurst.

The Gold Diggings at Bathurst in 1851. Henrietta Huxley. An interesting account of the excitement in New South Wales at the time of the discovery of gold, describing also the diggings. 4200 w. Nineteenth Cent—June, 1899. No. 28154 D.

British Columbia.

British Columbia Mines in 1898. W. M. Brewer. Information from the annual report of the Minister of Mines. 900 w. Eng & Min Jour—June 10, 1899. No. 28067.

Cyaniding.

Cyaniding Slimy Ores and Tailings. Matt. W. Alderson. Part first is a brief historical account of the early attempts to treat slimes in Montana. 1300 w. Min & Sci Pr—June 3, 1899. Serial. 1st part. No. 28046.

Klondike.

Geology of the Klondike Gold Fields. Angelo Heilprin. An interesting illustrated description of this region. 6400 w. Ap Pop Sci M—July, 1899. No. 28220 D.

Mexico.

The Topia District, Durango, Mexico. Frank B. Fowler. Describes this region; the ores are of silver, carrying a high percentage of lead. 1700 w. Eng & Min Jour—June 3, 1899. No. 27957.

Mining Practice.

Modern Practice in Gold Mining. John Hays Hammond. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Classifies and briefly discusses the problems. 1200 w. Col Guard—June 16, 1899. No. 28268 A.

New Zealand.

Report on the Auriferous Deposits of the Upper Hinemaia River. Alexander McKay. The government geologists' re-

port of the Taupo district, Auckland, N. Z. Did not find a payable prospect. 1600 w. N Z Mines Rec—April 17, 1899. No. 28033 B.

Nova Scotia.

The Pictou Coalfield, Nova Scotia. Harrison F. Bulman. An account of the collieries, the methods of working, equipment, management, etc. 3000 w. Col Guard—June 16, 1899. No. 28262 A.

Philippines.

Native Metallurgy in the Philippines. R. L. Packard. Describes the working of gold-bearing rock, and copper smelting. 1500 w. Eng & Min Jour—June 17, 1899. No. 28151.

Production.

The Increasing Production of Gold. Dr. H. M. Chance. A discussion of the enormous increase in the world's production of gold, and its effect upon prices of general commodities. The writer's prediction of three years ago is shown to be amply fulfilled. 3000 w. Engineering Magazine—July, 1899. No. 28381 B.

United States Gold and Silver Production in 1898. The corrected estimate, showing a very large gold production and an increase in silver. 1500 w. Eng & Min Jour—June 10, 1899. No. 28065.

Sampling.

Methods of Testing and Sampling Placer Deposits. Edmund B. Kirby. Read before the Colorado Scientific Society. Describes the best way of carrying on the work. 2000 w. Min & Sci Pr—June 17, 1899. Serial 1st part. No. 28207.

Notes on Mine Sampling. George J. Bancroft. Describes the methods in use, and the most satisfactory. Also the method of estimating the value of the mine. Ill. 2000 w. Min & Sci Pr—June 17, 1899. No. 28206.

Slimes.

Filter-Press Process of Gold Ore Slimes. William McNeill. Abstract of paper read before the Inst. of Min. and Met. in London. The process consists in the coagulation of the slimy particles by adding lime, settlement and treatment by weak cyanide solutions. 2800 w. Min & Sci Pr—June 17, 1899. No. 28208.

The Indirect Advantages of a Slimes Plant. John R. Williams. Notes claiming an increase in amalgamation and other profits. Discussion. 2000 w. Jour of Chem & Met Soc of S Africa—April, 1899. No. 27993 E.

South Africa.

Pilgrim's Rest. Malcolm Fergusson. Describes the situation of this rich South African field, its geological formation,

and the conditions under which it is worked. Ill. 1600 w. Mines & Min—June, 1899. Serial. 1st part. No. 27961 C.

Sulphides.

Reduction of Sulphides. The new process for the treatment of the sulphides of Broken Hill and Mount Reid in Australia. 3000 w. Aust Min Stand—May 11, 1899. No. 28252 B.

Tasmania.

Mining in Tasmania. A review of the great progress in this industry, and in the industries dependent on it. 11000 w. Aust Min Stand—April 27, 1899. No. 28036 B.

The Mount Read Mines. Report of the deposits and the difficulties arising from the presence of zinc. Ill. 5500 w. Aust Min Stand—April 27, 1899. No. 28037 B.

Testing.

Testing Gold Ores for Treatment by Concentration and Amalgamation to Determine the Best Method of Extraction. H. Van F. Furman. Describes laboratory work by which the kind of mill or the process suited to any ore can be determined before going to the expense of a mill test. Ill. 3200 w. Mines & Min—June, 1899. No. 27960 C.

Transvaal.

Mechanical Problems with Special Reference to Gold Mining in the Transvaal. Fearnside Irvine. Read before the Engineering Conference of the Inst. of Civ. Engs., England. Gives the practice in mine pumping, deep-level hoisting, ventilation, milling, treatment, etc. 1500 w. Col Guard—June 16, 1899. No. 28269 A.

The Rose Deep Gold Mine. Brief account of the methods now in use for the extraction of the metal from the ore, illustrated by photographs of the machinery employed at the mine named, situated near Johannesburg, in the Transvaal. 1500 w. Engr, Lond—June 16, 1899. No. 28261 A.

IRON AND STEEL.

Bar Iron.

Suggested Improvements in the Manufacture of Bar Iron. Samuel Peters. Describes a method which the author thinks will give desirable results, and it is hoped furnish a wrought iron that will compete with steel. 2500 w. Pro of Eng's Soc of W Penna—May, 1899. No. 28287 D.

Books.

Best Books for an Iron and Steel Works Chemist. Albert Ladd Colby. Calling the attention of chemists to the best English and American books in the

various branches of his analytical work, and warning him against the poor ones. 3000 w. Ir Age—June 15, 1899. Serial. 1st part. No. 28102.

Cast Iron.

Crystallization and Segregation of Cast Iron. C. Kreuzpointner. Extract from a discussion of a paper on "The Deceptive Fracture of Pig Iron," by Thomas D. West, read before the Am. Foundrymen's Assn. Showing that it is not the chemical composition alone that secures a sound casting. 1500 w. Eng News—June 1, 1899. No. 27933.

Crucible Steel.

See Mechanical Engineering, Materials.

Furnace Gas.

See Gas Engineering.

Iron Ore.

Our Iron Ore Supplies. Walter J. May. Suggestions for increasing the supplies of native iron ores without increasing the prices. 1000 w. Col Guard—May 26, 1899. No. 28005 A.

The Iron Ores of the Oural Mountains, Russia. H. B. C. Nitze. An illustrated description of this region, the development of the mines, the ores, etc. 1200 w. Jour Fr Inst—June, 1899. No. 27979 D.

Iron Production.

An Economic Study of the World's Production of Iron Ore and Pig Iron (Volkswirtschaftliche Studien über die Gewinnung der Eisenerze und die Erzeugung von Roheisen auf der Erde). Franz Kupelwieser. A very complete statistical review, with results tabulated by countries. Three papers, 12000 w. Zeitschr d Oesterr Ing u Arch Ver—June 2, 9, 16, 1899. No. 28331 each B.

Iron Trade.

A Review of the Iron Trade: Its Condition and Prospects. Charles Lancaster. Address before the Liverpool Chamber of Commerce. Considers the conditions in Great Britain. 1200 w. Col Guard—May 26, 1899. No. 28004 A.

Lapland.

The Great Magnetite Deposits of Swedish Lapland. David A. Louis. An account of the rich iron ore deposits of Northern Europe and the opening up of the region by railway construction. 3000 w. Engineering Magazine—July, 1899. No. 28386 B.

Puget Sound.

A Pacific Situs for Iron-Making. W. C. Cronmeyer. Investigations of the region around Puget Sound, to ascertain the prospects which that part of the country offered for the manufacture of

iron and steel. 3000 w. Ir Trd Rev—June 15, 1899. No. 28139.

Silicon.

Carbide of Silicon: Its Purpose and Use in Steel. F. J. Tone. Explains the action of silicon on foaming or boiling steel, its advantage over ferro-silicon, and the range of its application. 1800 w. Ir Age—June 22, 1899. No. 28195.

Slag.

The Utilization of Blast Furnace Slag. Alex. D. Elbers. Part first discusses the possibilities of this product, considering the most promising to be the utilizing it for building material. 1600 w. Eng & Min Jour—June 3, 1899. Serial. 1st part. No. 27955.

Steel Castings.

See Mechanical Engineering, Materials.

Temperature

The Influence of Casting Temperature Upon Steel. Robert Abbott Hadfield. Read before the Engineering Conference of the Inst. of Civ. Eng., England. Suggesting lines upon which research work should be based and indicating the present knowledge of this subject. 900 w. Col Guard—June 16, 1899. No. 28265 A.

MINING.

Air Pumps.

Points in Repairing Mining Air Pumps. Suggestions, with illustrations, for light repairs and cleaning. 1300 w. Am Mfr & Ir Wld—June 16, 1899. No. 28148.

Air Shafts.

Deepening an Air Shaft Under Difficulties. Illustrates and describes the most interesting portion of the work for rectifying the air-shaft of the Perron pit at the Bois d'Avroy Colliery, in the Province of Liège. 500 w. Col Guard—June 2, 1899. No. 28093 A.

Austria.

Austrian Mining Industries in 1897 (Der Oesterreichische Bergwerksbetrieb im Jahre 1897). Tabulated statistics from the official reports, classified and compared with the preceding year. 2500 w. Glückauf—June 10, 1899. No. 28344 B.

Cornish Mining.

The Position and Prospects of Cornish Mining. Joseph S. Martin. Notes from the annual report for 1898. Urging that the mines be properly equipped and wisely managed. 2000 w. Col Guard—May 26, 1899. No. 28003 A.

Dynamite.

Notes on Handling Dynamite. W. R.

Quinan. Written for the report of the mines inspector for Montana, for 1897. Describes how it should be stored, and how thawed and exploded. Also its effect on ventilation. 1500 w. Mines & Min—June, 1899. No. 27966 C.

Electric Power.

Electrical Transmission of Power in Mining. William Beedie Esson. Read before the British Inst. of Civ. Engs. Describes the plant at the Sheba Company's mines, Barberton, Transvaal. Ill. 8000 w. Col Guard—June 9, 1899. No. 28189 A.

Equalizing.

The Hoist Equalizer of the Camphausen Mine near Saarbruck (Der Seilgewichts-Ausgleichung der Grube Camphausen bei Saarbrücken). Describing the ingenious method of counterbalancing the variable weight of the cable in the hoisting machinery. 2000 w. Glückauf—June 3, 1899. No. 28343 B.

Explosives.

Experience with the Explosives Order in the Midlands. A. H. Stokes. From the inspector's annual report. Cautioning against placing too much reliance in the Woolwich test of explosives, with information relating to the use and care of explosives. 2800 w. Ir & Coal Trds Rev—May 26, 1899. No. 28014 A.

Recent Investigations as to Safety Explosives. M. G. Chesneau. From a communication to the French Firedamp Commission. Gives briefly the results that have been obtained in France, and reviews the results obtained in other countries. 4500 w. Col Guard—June 9, 1899. No. 28188 A.

The Safe Handling of High Explosives. Comments on the changes being made in the explosives used in mines, and the miners' unfamiliarity with the properties of those now used, giving the principal points to be observed in order to handle them with safety. 5000 w. Col Guard—June 9, 1899. Serial. 1st part. No. 28190 A.

Firedamp.

Continuous Examination of Pit Gas for Firedamp by the Krell Apparatus. P. Fuchs, in *Zeitschrift für Berg-Hütten und Salinenwesen*. Illustrated description of this method, which is based on the principle of the hydrostatic balance, and of the apparatus used. 1600 w. Col Guard—May 19, 1899. No. 27904 A.

Errors in Firedamp Control (Die Häufigsten Fehler bei der Wetterführung). A paper by Bergassessor Stens, discussing the proper method of mine ventilation to prevent the accumulation of fire damp. 2500 w. Glückauf—May 13, 1899. No. 28339 B.

Hoisting.

See Mechanical Engineering, Machine Works.

Ignition.

Progress in the Electric Ignition of Explosives (Fortschritte auf dem Gebiete der Elektrischen Zündung von Sprengschüssen). Bergassessor Heise. With a description of the electric igniters now in practical use and a discussion of the electrical features of the work. 3000 w. Glückauf—May 20, 1899. No. 28340 B.

Mining Law.

Royalties and Wayleaves and Their Treatment. George Johnson. An explanation of these terms and difficulties arising from them in the United Kingdom. 2800 w. Col Guard—June 2, 1899. No. 28094 A.

Mining Power.

See Electrical Engineering, Power Applications.

Old Mines.

Dangers of Old Mine Workings. Arthur Lakes. Gives some examples of how these dangers have been successfully met, and of accidents which they have caused. Ill. 1600 w. Mines & Min—June, 1899. No. 27965 C.

Ontario.

Mining in Ontario: Its Condition and Outlook. A review of the various branches of this industry. The production of petroleum, salt, natural gas, gold, iron, nickel, copper and other minerals. 2500 w. Can Min Rev—May 31, 1899. No. 27986 B.

Rescue Work.

Life Saving in Mines, with Special Reference to the Coal Mining District at Ostrau-Karwin, Austria. A paper read by Mining Engineer H. Rossner, manager of the Archducal Shaft of Hohenegger, before a meeting of German engineers in Munich. Ill. 3600 w. Mines & Min—June, 1899. No. 27962 C.

Shafts.

Iron Lining to Shaft for Catching the Water. M. Vrancken. From an administrative report published in the *Annales des Mines de Belgique*. Describes the manner of overcoming the incursion of water in the winding shaft. 1400 w. Col Guard—June 16, 1899. No. 28266 A.

Timbering.

Mine-Timbering and Accidents in Mines. A. H. Stokes. Suggestions of a general character, considering the timbering of roadways, removal of broken pumps, setting bars, setting props in the stalls, etc. 2800 w. N Z Mines Rec—April 17, 1899. No. 28032 B.

Timbering Underground Workings. George L. Kerr. Extract from a paper read before the Min. Inst. of Scotland. Illustrates and describes the kind of timber and the methods of setting for supporting workings in various kinds of ground. 1400 w. Mines & Min—June, 1899. No. 27963 C.

Underground Water.

Underground Water. An interesting case recently decided in the Court of Appeal, England. 2500 w. Col Guard—May 26, 1899. No. 28002 A.

Water. W. M. Watson. On the supply of water, how to tell where water will be found by boring, the importance of a pure supply, and some facts concerning mineral springs, etc. 3000 w. Can Engr—June, 1899. No. 28057.

MISCELLANY.**Bismuth.**

Bismuth Ores in N. S. W. J. A. Watt. Gives some of the characteristics and uses of this comparatively rare metal, with a list of the localities in New South Wales from which bismuth ores have been recorded. 3800 w. Aust Min Stand—May 4, 1899. Serial. 1st part. No. 28038 B.

Bronzes.

See Mechanical Engineering, Materials.

Conveyor.

See Mechanical Engineering, Power and Transmission.

Graphite.

Graphite: Its Formation and Manufacture. E. G. Acheson. Gives the early history, distribution, uses, manufacture, theory of formation, etc. 4500 w. Jour Fr Inst—June, 1899. No. 27981 D.

Handling Minerals.

See Mechanical Engineering, Power and Transmission.

Onyx.

The Onyx Deposits of Barren County, Kentucky. S. S. Gorby. An illustrated description of the deposits and their location. 1500 w. Eng & Min Jour—June 17, 1899. No. 28150.

Phosphate.

The Mount Pleasant Phosphate District, Tennessee. H. D. Ruhm. An account of this field, where somewhere near \$600,000 have been invested. 2200 w. Eng & Min Jour—June 10, 1899. No. 28068.

Pyrometer.

The Uehling and Steinbart Pneumatic Pyrometer (Pneumatisches Pyrometer von Uehling & Steinbart). With detailed drawings and a photographic view

of the apparatus. 2000 w. Stahl und Eisen—May 1, 1899. No. 28337 D.

Salt Deposits.

The Strassfurt Region Salt Deposits in Germany. H. B. Nitze. Describes these deposits with special reference to the potassium and magnesium salts. 2600 w. Mines & Min—June, 1899. No. 27968 C.

Slag.

Potash and Soda Salts from Natural Decomposition of Lead Slags. Malvern W. Iles and Charles F. Shelby. A state-

ment of facts obtained in the analysis of a white efflorescent salt found at the base of a slag dump. 600 w. Eng & Min Jour—June, 1899. No. 27956.

Structure.

The Crystalline Structure of Metals. J. A. Ewing and W. Rosenhain. Abstract of the Bakerian lecture before the Royal Soc. Some results of microscopical study considering the effects of strain and the relation of plasticity to crystalline structure. 2200 w. Elect'n, Lond—June 9, 1899. No. 28176 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

English Railroad Accidents in 1898. Editorial comment on the Board of Trade report. 1000 w. R R Gaz—June 2, 1899. No. 27941.

Train Accidents in the United States in April. Detailed list and classified summary. 2500 w. R R Gaz—June 2, 1899. No. 27940.

Paris Exposition.

Railways at the Paris Exposition. Willard A. Smith. The first of a series of articles aiming to give an idea of the plans and prospects of the American exhibit of transportation and civil engineering. 1500 w. Ry Mas Mech—June, 1899. Serial. 1st part. No. 28147.

Special Train.

A Run with a Webb Four-Cylinder Compound. Charles Rous-Marten. An account of a special trip of the Engineering Conference of the Inst. of Civ. Engrs. from London to Crewe and back. 1800 w. Engr, Lond—June 16, 1899. No. 28259 A.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

Air Brake Appliances. Report of the committee of the M. C. B. Assn., presented to the annual convention at Old Point Comfort. Ill. 1000 w. Ry Age—June 16, 1899. No. 28144.

Organizing and Conducting the Air Brake Department of a Railroad. Extracts from a paper presented at meeting of the Assn. of R. R. Air-Brake Men, in Detroit. Suggestions of what should be required. 1900 w. Ry & Engng Rec—June 3, 1899. No. 28020.

Brake Beams.

Solid Brake Beams. R. H. Angier. A discussion of metal brake beams, describing the practice of European railroads. Also editorial. Ill. 3200 w. R R Gaz—June 9, 1899. No. 28054.

Cars.

100,000-Pound, Steel Frame, Hopper Cars—Norfolk & Western Railway. Illustrated description. Also arguments by R. P. C. Sanderson favoring this form of construction. 2500 w. Am Engr & R R Jour—June, 1899. No. 27920 C.

Car Wheels.

The Heating of Car Wheels and Its Relation to the Heat Test. Gives results of some novel experiments for determining the temperature to which drilled wheels can be heated by brake shoes under severe conditions, and the relation of this heating effect to the usual thermal test. Also editorial. 4200 w. R R Gaz—June 9, 1899. No. 28053.

Couplers.

A Possible Solution of the Coupler Problem. Discusses the report of the M. C. B. Coupler Committee, outlining a plan for solving the coupler problem. 1300 w. R R Gaz—June 9, 1899. No. 28052.

Improving the M. C. B. Coupler. Gives the full report of the committee appointed by the Western Ry. Club; also the views of Mr. John Hickey. Ill. 3000 w. Ry Age—May 26, 1899. No. 27905.

Proposed New Contour Lines and New Specifications for M. C. B. Couplers. Abstract of committee report presented at the annual convention of the Master Car Builders' Assn. at Old Point Comfort, Va., June, 1899, with editorial. Ill. 5000 w. Eng News—June 22, 1899. No. 28214.

Some Notes on the M. C. B. Coupler. Gustave Giroux. Suggestions as to methods of strengthening it. 2700 w. Ry Mas Mech—June, 1899. No. 28146.

The Car Coupler Problem. Points out some of the reasons for the rupture of coupler heads and stems, the rapid destruction of the wearing parts, etc., believing accidents are chiefly due to curable conditions of impact and draft. 1800 w. R R Car Jour—June, 1899. No. 28061.

The M. C. B. Coupler. John Hickey. A communication making a reply in part to the comments on the writer's report of Jan. 19, 1899, relative to automatic link and pin couplers versus M. C. B. type. 1800 w. R R Car Jour—June, 1899. No. 28062.

Electric Locomotives.

See Electrical Engineering, Power Applications.

Exhaust Nozzle.

A New Locomotive Exhaust Nozzle. Data regarding tests made at the University of Illinois, of locomotive exhaust nozzles, comparing the action of a new nozzle, designed by Don Sweney, with the Smith triple-expansion nozzle and several round nozzles. 2200 w. R R Gaz—June 16, 1899. No. 28142.

Large Cars.

Canda's 100,000 Lbs. Capacity Cars. Illustrates designs of a box car, a double hopper bottom coal car, and a truck for use under cars intended to carry loads of 100,000 pounds, on the Southern Pacific R. R. 3800 w. R R Gaz—June 9, 1899. No. 28051.

100,000 Pound Hopper Car, Norfolk & Western Railway Company. Illustrated description of a plain strong construction intended for hard service. 600 w. R R Car Jour—June, 1899. No. 28063.

Locomotives.

American Locomotives for Foreign Railways. Detailed information, with illustrations, showing the great extent to which American locomotives are now used, with editorial discussion of the general causes which have led to their export. 6000 w. Eng News—June 15, 1899. No. 28104.

Compound Locomotives. Francis William Webb. Read before the Engng. Conference of the British Inst. of Civ. Engrs. An explanation of the system of compounding used by the author, reporting the economy of pull due to compounding to be 19 to 20 per cent. 1800 w. Engng—June 9, 1899. No. 28183 A.

Coupled Express Locomotive for the Palatinate Railways (Locomotive Express Accouplés des Chemins de Fer du Palatinat). F. Barbier. With plate of sections and details, and computations of tractive power. 2000 w. 1 plate. Le Génie Civil—May 27, 1899. No. 28304 D.

Economics of Freight Locomotive Operation. G. R. Henderson. Gives data which point to the conclusion that ten miles is the most economical speed on parts of the road not level, but that on level stretches the speed can be varied. 1800 w. Am Engr & R R Jour—June, 1899. No. 27925 C.

English and American Locomotive

Building. Charles Reus-Marten. A timely discussion of the causes which have led to the placing of extensive orders in the United States for locomotives for British railways. 4000 w. Engineering Magazine—July, 1899. No. 28380 B.

Express Passenger Locomotive for the London and South-Western Railway. Illustrated description and particulars. 700 w. Engng—June 16, 1899. No. 28270 A.

Flanged Tires for Mogul, Ten-Wheel and Consolidation Locomotives. Abstract of a committee report presented at the annual convention of the Am. Ry. Mas. Mchs.' Assn., at Old Point Comfort, Va., June, 1899. 1200 w. Eng News—June 22, 1899. No. 28210.

Locomotive Progress. A review of recent development and improvement in design. 1800 w. Ry Mas Mech—June, 1899. No. 28145.

Notes on the Effect of Ports and Valve Gears on the Performance of High Speed Locomotives. R. A. Smart. Shows the importance of careful attention to the design and construction of valve gears and ports, and the effect on the capacity of the locomotive at high speeds. 800 w. Am Engr & R R Jour—June, 1899. No. 27927 C.

Old and New Belgian Express Locomotives. Engravings showing two very different types designed for the same service, with a brief account of the performance of the improved machine. 400 w. Loc Engng—June, 1899. No. 27907 C.

Parallel in the Development of the Locomotive and Electric Car Truck. John A. Brill. Illustrated account showing a remarkable and interesting parallel in the successive steps by which the development has progressed. 1500 w. Ry Wld—June 8, 1899. No. 28223 D.

Powerful 8-Wheel Passenger Locomotives—Chicago & Northwestern Railway. Illustrations and full description of these fast-mail locomotives. 700 w. Am Engr & R R Jour—June, 1899. No. 27921 C.

Standard Consolidation Freight Locomotives—Pennsylvania Railroad. Illustrated detailed description of the heavy freight engines, classes H5 and H6. 4000 w. Am Engr & R R Jour—June, 1899. No. 27919 C.

The Atlantic Type and the Wide Firebox. J. Snowden Bell. Calls attention to the special capabilities and advantages of this type of engine in connection with the use of the wide firebox. 2300 w. Am Engr & R R Jour—June, 1899. No. 27926 C.

The Determination of the Friction Losses of Locomotives. W. F. M. Goss. Extract from an article published in the Purdue University *Exponent*. Gives data seeming to show a loss in draw-bar pull due to engine friction of about 500 pounds, or about 67 horse-power, with

the locomotive running at 50 miles per hour. 2000 w. R R Gaz—June 9, 1899. No. 28055.

The Development of the Tank Locomotive. Arthur E. Kyffin. An illustrated review of various types of tank locomotives, with interesting data. 3000 w. Mech Wld—June 9, 1899. Serial. 1st part. No. 28167 A.

The Simple and Compound Consolidation Locomotives of the Atchison, Topeka & Santa Fe. An account, with illustrations, of the tandem compound and the simple engines, with data from careful service tests extending over several months. 4400 w. R R Gaz—June 16, 1899. No. 28140.

Motor Cars.

Steam Motor Cars for Branch Lines. Illustrated description of a car constructed by the Baldwin Locomotive Works for the Cincinnati, Hamilton & Dayton Railroad. 700 w. Sci Am—June 24, 1899. No. 28200.

Passenger Cars.

New Bogie Carriages. Illustrates and describes some bogie composite corridor lavatory carriages being constructed for English railways. 500 w. Engr, Lond—June 2, 1899. No. 28089 A.

Piston Valves.

Piston Valves for Locomotives. F. M. Whyte. On the application of piston valves to locomotives, the use of packing rings, effect on balancing, etc. Ill., 2700 w. Am Engr & R R Jour—June, 1899. No. 27923 C.

Reports.

Reports to the Master Mechanics' Association. Abstracts of reports presented by the various committees of the American Railway Master Mechanics' Association, at the convention in Old Point Comfort, Va. 12500 w. R R Gaz—June 23, 1899. No. 28225.

Sleeping Cars.

The International Sleeping Car Company of Europe. E. G. An account of the operations of this company, the growth and present extent, with interesting particulars of the service rendered. 1700 w. R R Gaz—June 9, 1899. No. 28056.

Valve Gear.

Positive-Motion Corliss Valve Gear (Zwangläufige Corlissteuerungen). H. Dubbel. A Corliss valve gear without trip motion, arranged especially for locomotives. Data of tests are given showing the economy of a locomotive with this gear over the slide valve. Two articles, 7000 w. Zeitschr d Ver Deutscher Ing—June 10, 17, 1899. No. 28323 each D.

Vestibules.

The Vestibule Car. Arthur H. Giles. Illustrates and describes various forms, comprising the most important inventions in vestibules and vestibule cars. 1000 w. R R Car Jour—June, 1899. No. 28064.

Wheels.

Car-Wheel Construction. Edward Grafstrom. Gives a method of analyzing the stresses in a wheel. Ill. 2800 w. Am Engr & R. R. Jour—June, 1899. No. 27922 C.

NEW PROJECTS.

Argentina.

Light Railways in Argentina. A general report of the light railways and the laws relating to them. 500 w. U S Cons Repts, No. 451—June 14, 1899. No. 28100 D.

China.

New Chinese Railway from Canton to Hankow. A general outline of the work, furnished by William Barclay Parsons, who had charge of the surveys. 1000 w. Eng News—June 15, 1899. No. 28105.

The Hankow-Canton Railroad. Interesting information concerning the line recently surveyed by William Barclay Parsons, known as the "Brice Concession." 1200 w. R R Gaz—June 16, 1899. No. 28141.

India.

Indian Railway Extension. On the evidences of recent progress, the new lines opened, their cost, etc. 2000 w. Engr, Lond—May 26, 1899. No. 28009 A.

Mexico.

Railway Construction in Mexico. Reports an interview with John P. Ramsey, general manager of the Rio Grande, Sierra Madre & Pacific Railroad. 1500 w. U S Cons Repts, No. 451—June 14, 1899. No. 28098 D.

Peru.

Proposed Railway in Peru. Translation of a government decree under which bids are invited for the construction of a line from Oroya to Cerro de Pasco. 1400 w. U S Cons Repts, No. 452—June 15, 1899. No. 28119 D.

Switzerland.

American Capital in Swiss Railways. Information concerning existing roads, railways projected and in course of construction, concessions, etc. 2200 w. U S Cons Repts, No. 455—June 19, 1899. No. 28166 D.

Uruguay.

The Railways of Uruguay. Reliable information concerning the railways, their operation and financial condition. 1800 w. U S Cons Repts, No. 456—June 20, 1899. No. 28173 D.

Venezuela.

Railway Contract in Venezuela. Translation of a recent concession for the construction of a road between Puerto Cabello and Yaritagua. 1200 w. U S Cons Repts, No. 453—June 16, 1899. No. 28135 D.

PERMANENT WAY AND FIXTURES.**Culverts.**

Comparison of Cost and Efficiency of Various Styles of Small Railway Culverts. Hunter McDonald. Part of a paper read before the Engng. Assn. of the South. The different materials used are reviewed, and the construction discussed. 3000 w. Ry & Engng Rev—June 3, 1899. No. 28021.

Hamburg.

The Rearrangement of the Railway Terminal at Hamburg (Die Ungestaltung der Eisenbahn-Anlagen in Hamburg). With a plan showing the improved arrangement of tracks, stations and warehouses to be used in connection with the harbor traffic. Two articles. 1 plate. 6000 w. Deutsche Bauzeitung—May 13, 20, 1899. No. 28351 each B.

Signalling.

Electro-Pneumatic Signalling Plant. Illustrates and describes an interesting signalling plant recently carried out for the Great Eastern Railway Co., of England. 2500 w. Engng—June 16, 1899. No. 28271 A.

Sleepers.

The Artificial Preservation of Railroad Ties by the Use of Zinc Chloride. Walter W. Curtis. Report of the author's investigations to determine the value of the treatment, with a résumé of knowledge on this subject. 19000 w. Pro Am Soc of Civ Engs—April, 1899. No. 28117 E.

The Use of Beech Wood for Railway Sleepers (Ueber Verwendung von Buchenholz zu Eisenbahnschwellen). A paper by Ober-Baurath Wetz before the German Railway Association, with discussion, mainly concerning the best method of preserving such sleepers from decay. 6000 w. Glaser's Annalen—May 15, 1899. No. 28346 D.

Station.

Improvement of the Grand Central Station, New York. Describes and illustrates plans for the construction of a large waiting room for the use of all divisions, changes in the trainshed, and other improvements, all of which must be carried out without interrupting the immense traffic. 2300 w. R R Gaz—June 23, 1899. No. 28226.

Remodeling the Grand Central Station, New York. Illustrated description of the improvements to be made, with details of the iron construction. 2000 w. Eng Rec—June 17, 1899. No. 28164.

The Enlargement of the Waverley Station, Edinburgh. From the *Scotsman*. Extract from an interesting account describing the remodelling of the North British Co.'s Waverley Station at Edinburgh, 1200 w. Transport—May 26, 1899. No. 27995 A.

The Reconstruction of the Main Station of the Vienna Municipal Railway (Umbau und Neubau des Hauptzollamts-Bahnhofes der Wiener Stadtbahn). A. Oelwein. With details of bridge and elevated railway construction and plans of station and approaches. 5000 w. 2 plates. Zeitschr d Oesterr Ing u Arch Ver—June 9, 1899. No. 28332 B.

Terminal.

The New Terminal Station of the Orleans Railway (La Nouvelle Gare Terminus de la Cie d'Orleans). An illustrated account of the progress of the work upon this new terminal in Paris, showing the present condition of the work on the Quai d'Orsay. 3500 w. Le Génie Civil—June 10, 1899. No. 28306 D.

Transition Curves.

See Civil Engineering, Measurement.

TRAFFIC.**Railway Operation.**

Some Principles Governing the Proper Distribution of Locomotives in Economical Railway Operation. E. M. Herr. Notes the points to be studied to secure the proper distribution of power. 1500 w. Am Engr & R R Jour—June, 1899. No. 27924 C.

STREET AND ELECTRIC TRAMWAYS

Amiens.

The Electric Tramway of Amiens (Les Tramways Electriques d'Amiens). With illustrations of the power plant, the overhead conductors and the cars, and a general description of the installation. 1500 w. L'Electricien—May 13, 1899. No. 28372 B.

Conductors.

Overhead Conductors for Electric Railways (Die Oberleitung Elektrischer Strassenbahnen). Max Schiemann. A very complete discussion of the best methods of constructing overhead trolley lines, including the trolleys and communication to the cars, as well as the sup-

port and arrangement of the conductors. Two papers, 10000 w. *Elektrotech Zeitschr*—May 11, 18, 1899. No. 28353 each B.

Contact System.

The Diatto System at Tours (Das Diatto-System in Tours). Giving a section of the conduit and showing how the contact is made with the moving car. 1500 w. *Elektrotech Zeitschr*—June 8, 1899. No. 28362 B.

The Diatto System of Electric Traction. From *La Vie Scientifique*. Illustrates and describes the system as operated at Tours, France. 1700 w. *Engr, Lond*—May 26, 1899. No. 28012 A.

The Tramways of Tours (Les Tramways de Tours). J. A. Montpellier. A fully illustrated account of the installation of the Diatto contact system of electric traction at Tours, with map of the tramway system. 2500 w. *L'Elec-tricien*—April 29, 1899. No. 28368 B.

Cross-Country.

An Interesting Cross-Country Electric Road. Illustrated description of the tramway from Dayton to Eaton, Ohio. 1000 w. *St Ry Jour*—June, 1899. No. 27948 D.

Dundee.

Dundee Tramways. Report of E. Manville to the tramway committee of the corporation of Dundee, on the proposed extensions, and other changes under consideration. 7000 w. *Elec Eng, Lond*—June 16, 1899. No. 28250 A.

Electric Locomotives.

See Electrical Engineering, Power Applications.

Electric Railways.

Edison Electric Railways of 1880 and 1882. Edwin W. Hammer. An illustrated account of Mr. Edison's railway work at Menlo Park. 4000 w. *Elec Wld & Elec Engr*—June 10, 1899. No. 28059.

Electric Traction.

Mechanical Traction by Electricity. Granville C. Cunningham. Read before the British Inst. of Civ. Engs. Briefly considers how this form of traction compares in cost of construction and working. Discussion. 2800 w. *Elec Eng, Lond*—June 9, 1899. No. 28171 A.

The Generation of Power for Electric Traction. J. Gray Scott. Considers the combined supply for lighting and traction, giving special attention to the practical working of a tramway power station. 1600 w. *Elec Rev, Lond*—June 16, 1899. Serial. 1st part. No. 28246 A.

Finances.

Financial Analysis of the Brooklyn

Rapid Transit System. Statement of the new financial conditions and the possibilities of future development. 2000 w. *St Ry Jour*—June, 1899. No. 27951 D.

London.

London United Tramways. Map and description of the system of tramways being constructed by this company. 2000 w. *Ry Wld*—June 8, 1899. No. 28222 A.

Milwaukee, Wis.

The Electric Railway System of Milwaukee and Eastern Wisconsin. An illustrated detailed description of a remarkable system, with an account of the equipment, operation and financial results. 8000 w. *St Ry Jour*—June, 1899. No. 27946 D.

Paris.

The Metropolitan Railway of Paris (Le Métropolitain de Paris). G. Leugny. A description of the progress of the underground work, showing the operation of the shield and the methods of manipulation. 2000 w. *La Revue Technique*—June 10, 1899. No. 28310 D.

Pneumatic System.

A Singular Railway Experiment. Describes experiments made by John Vallance, of Brighton, Eng., in 1826 and 27. The system was patented but never attempted on a commercial scale. 1400 w. *Engr, Lond*—May 19, 1899. No. 27901 A.

Pneumatic Propulsion. A brief history of this subject and the work of English inventors. 2500 w. *Engr, Lond*—June 2, 1899. No. 28088 A.

Rail Welding.

See Electrical Engineering, Heating and Welding.

Speed.

Speed-Tests on the Cleveland-Lorain Railway. Statistics on the speeds secured during trial runs and in regular service. 900 w. *St Ry Jour*—June, 1899. No. 27950 D.

Three-Phase.

Three-Phase Transmission for Railway Service Near Philadelphia. Illustrates and describes the line of the Philadelphia and Westchester Traction Co., and also its equipment. 1700 w. *St Ry Jour*—June, 1899. No. 27947 D.

Tracks.

Street Railway Track Construction. M. D. Burke. Brief description of construction for horse-cars, the transition to tracks for motors in present use, with suggestions of such forms as appear appropriate for existing conditions. Ill. 5800 w. *Jour Assn of Engng Socs*—April, 1899. No. 27914 C.

THE ENGINEERING MAGAZINE

VOL. XVII.

SEPTEMBER, 1899.

No. 6.

AMERICA, ENGLAND, AND GERMANY AS ALLIES FOR THE OPEN DOOR.

By Hon. John Barrett, late U. S. Minister to Siam.

I.—IDENTITY OF INTERESTS DICTATING A UNITY OF POLICY.

AMERICA, England, and Germany have it in their power, by united action, to preserve the integrity of the Chinese Empire, and to maintain forever the freedom of trade throughout her entire extent from Kwangtung to Manchuria and from Kiangsu to Szechuan. Whether they will take advantage of this mighty responsibility remains to be seen. The fact that they have this power is not fully appreciated. The heads of these respective governments may be willing to pursue a strong joint policy in China, but that the people themselves are ready to support them is not yet proved. The work of education must go on.

In England and in Germany there is a more prevailing tendency to uphold their governments in a Chinese policy than in America, but in Germany the interests at stake do not yet fully understand the situation. In Great Britain the people are even more earnest than the Foreign Office in their advocacy of the protection of their rights; while Americans from New York to San Francisco should favor a vigorous attitude on the part of the government in China because all sections of the country are deeply concerned in keeping open a vast field of trade which Americans have only begun to exploit. Amer-

The acquirement, by the United States, of interests in the far east is the most certainly fruitful event of modern times. It means that America will henceforth extend her industries—and hence her politics—along lines parallel with those run by Great Britain and Germany. The Hon. John Barrett, for many years an observant student and traveler in China, Japan, and the Philippines, and for four years United States Minister to Siam, speaks as one having authority. His arguments, addressed to the engineering world whose interest is first and greatest, should be forceful in awakening a true appreciation of the merits of the case and in shaping that popular opinion which is the mainspring and the controller of the action of all representative governments. THE EDITORS.

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ican manufacturing industries and shipping interests have so developed that the United States are now able to export manufactured and natural products to China and compete successfully with the two other great industrial nations of the world, England and Germany.

These two countries, while recognizing the position that America is taking as a competitor for the world's trade, believe that they are able to hold their own, and are willing to start with her in an even race for the profits of the markets of China. Although America has a protective tariff for her home industries, there is no complaint among her manufacturers and exporters that, in the major proportion of the articles sent to China, they are not able to compete successfully with England, Germany, and other nations. Whether this capability of competition is due to the perfection of manufacturing, favorable shipping rates, or enterprise of exploitation, the fact exists. This enables the American who is concerned in the commerce of China to join hands, as it were, with his brother trader of Great Britain and Germany in protecting and extending the markets of Asia.

If the policy of Germany in Shantung were studied, it would be found that the position she occupies there is inspired by ambitions of empire and power, more than by demands of her manufacturers and exporters that they have an exclusive field. The German manufacturer and his agent in Asiatic ports know that he needs no discriminating tariff in order to compete in the markets of the Orient. In the same way, England's position at Hong Kong, Singapore, and Wei-hei-Wei finds its inspiration in her desire to be a world power and to be able everywhere to protect her great and growing interests. The manufacturers and exporters of England realize the importance and value of the possession of such strategic points, but you seldom hear them making any complaint on the point of competition where they have equal rights of trade with the merchants of other nations.

Thus we have a situation which is peculiarly favorable to the harmonious working of America, England, and Germany for the preservation of the integrity of China and the maintainance of the "open door" throughout her great area. Each power has guaranteed to it by the Tien Tsin treaties no limitations of its commercial rights. If they insist, through all conditions, that those treaties shall not be abrogated or infringed, their merchants, capitalists, and investors, as well as manufacturers and engineers, need have no fear as to the future. A generous rivalry now exists throughout the world between these three powers for the increase of their foreign exports. If they realize

what they have to gain in China by keeping her intact, and what they have to lose by her division, they may be forced to take a position which will enable them to protect what they already have and provide for an unlimited extension in the future.

FIELD FOR COMMERCE AND ENGINEERING.

Among China's uncounted millions and in her wide area is a market for the surplus product of all these countries. I do not mean that this market would consume their surplus were all other foreign markets cut off, but with the growing demands of South America, South Africa, and other portions of Asia, Europe, and America, there is in China a greater undeveloped field than in any other of the countries named. In other words, China has the largest specific market, whose limit has not yet been reached, of any important section of the world.

With the commercial exploitation of China's area and people must come that imperative demand for the skill of the engineer and for the products of his hand as well as those of the manufacturer. Wherever commerce goes, there follows the necessity of the engineer's presence.

It is no exaggeration to state that the engineers of the world can now see before them in Asia, and in China in particular, more manifold opportunities for their work than in any other portion of the world where material progress has only begun its mighty undertakings. Engineering projects of all kinds go hand in hand with commercial expansion. Wherever the manufacturer, the exporter, or the missionary goes, whether in person or through his labors, there will presently be a demand for the engineer. The articles of trade which penetrate into the innermost parts of China and other Asiatic lands are only the forerunners of greater developments that follow. They are the initial influences that lead to great movements, and no great movement now is accomplished without the aid of the engineer, as well as that of the merchant and diplomatist. The more one travels, not only through China, but through Japan, Corea, Eastern Siberia, Indo-China, Siam, Malay Peninsula, Java, Borneo, Formosa, and the Philippines, the more is he convinced that their future progress and prosperity depend, perhaps, more upon the engineer than upon the exporter, manufacturer, merchant, missionary, and diplomatist. Although my experience has been largely in diplomacy, what I have repeatedly seen has convinced me that the engineer is perhaps to-day the most essential personal element in the development of these unknown Asiatic countries. He will act and be successful where the di-

plomatist, missionary, and business man fail. There is an eminently practical side to his efforts which is beginning to appeal to the easy-going nature of the Asiatic. A decade or more ago the Asiatic despised and hated the engineer and everything connected with him, but now he is beginning to realize what advantages, changes, happiness, and comfort this most remarkable of all varieties of foreigners can accomplish. He may rise up at first in opposition to the engineer's plans and his works, even destroying them, but in time he recognizes his mistake and loves the man whom before he has distrusted, taking advantage of all his devices and using them as if he had been accustomed to them by the habit of centuries.

When the Chinese cast the first railway from Shanghai to Woosung into the river, they were only preparing themselves for a network of railways all over China. When the Koreans in Seoul destroyed the new electric line in that city and burned the cars, they were only having a serious celebration prior to a happy acceptance of this new method of locomotion in which they would crowd these radical means of conveyance and bring good dividends to the stockholders. After the Siamese had looked at the wondrous movements of the first electric railway that ran through the great city of Bangkok, they muttered a few complaints about its speeding along too rapidly and not giving them sufficient time for rest, and then concluded that it was the best scheme for saving extra exertion in walking which their crude minds had ever conceived! The engineer should have little fear as to the ultimate success of his enterprises in Asia. The field is so wide and the rewards so tempting that all of the engineers of the United States, England, and Germany should be arrayed in support of a policy which will protect and develop the utilization of their talents throughout all China.

PERSONAL STUDY OF THE FIELD.

That those who are good enough to read this article—which I have consented to write only at the earnest solicitation of the Editor—may understand why I am so earnest in regard to the Asiatic opportunity, I may possibly be pardoned for referring to my personal study of the far east. Appointed United States Minister to Siam in the early part of 1894, where I was sent to settle the long standing Cheek case, I devoted my leaves of absence to traveling through the principal countries of eastern Asia, studying both material and political conditions. The reach of my investigations extended from Batavia, Singapore, and Bangkok on the south, to Peking, Vladivostock, and Tokio on the north, including frequent visits to Manila, Hong Kong,

Canton, Shanghai, Hankow, Tien Tsin, Chemulpho, Kobe, and Yokohama. Not contented with visiting the coast ports, I more than once found my way to distant interior points. In short, my observations are based on over five years' careful observations of the principal countries and cities of eastern Asia, both in a diplomatic and private capacity. When I left my post of duty at Bangkok in 1898, I went directly to Manila by courtesy of Admiral Dewey soon after his great victory, and remained there off and on for nearly a year, through war, peace, and war again, until this last March when personal matters in America required my return,

It is not my desire by this reference to personal experience to exaggerate in any way the importance of my own opinions, or to call attention in the slightest degree to my own achievements or record. My simple purpose is to show to the majority of the readers of *THE ENGINEERING MAGAZINE*, who may not be familiar with my association with Asiatic matters, that I am not basing my conclusions on the opinions of others or upon a study of the field made through long-distance glasses. There are, moreover, many who are far better authorities than I can hope or claim to be. If they differ from me, I trust that they will at least give me credit for sincerity. It is not to be expected that my humble opinions will coincide with those of all students of the far east, or that theirs will agree with mine. The field is so vast and the policies to be pursued in its development have so many bearings that it would be remarkable if all authorities were in accord. I have great respect for the judgment of those who are opposed to my inferences, and I trust that they will reciprocate the sentiment.

THE INFLUENCE OF NATIONS.

Commerce is the lifeblood of nations. It is the strong, virile element of progress that gives force to moral power. Without vast trade interests, it is impossible for a country to exercise a vigorous political influence throughout the world. Whenever a new field of commercial expansion is being opened to the competition of all nations, it should be the one purpose of those which control the major portion of the world's trade to see that it is never closed. Countries which have nothing to lose by limiting the extent of Asiatic markets will direct their energies to dividing up the territory concerned; it should, therefore, be the policy of those which have everything to gain, by enlarging such areas of exploitation, not only to keep them free and unrestricted to all competitors, but to prevent the impending division.

America, England, and Germany, as the three leading industrial nations, easily outstrip all others. They have taken the first three positions in the line of the world's competition, and will probably hold them at least for the next half century. What combinations or sweeping changes may be effected in the meantime no one can safely foretell, but the living indications point to Anglo-Saxon and Teutonic supremacy in the material and political struggle of the principal powers.

France, Austria, Italy, and Spain can never hope to outstrip Germany or England. Russia, the only remaining power that can be considered in this comparison, is largely an unknown quantity. From past experience and from present conditions it might be said that she is not destined to be a dangerous competitor in the race for commercial leadership, unless she is able to control the great markets of Asia by breaking down the Tien Tsin treaties, developing spheres of influence, and granting discriminating rates over her Trans-Siberian railway. This she will not be able to do if England, Germany, and America unite to prevent such eventualities, nor will she herself endeavor to carry out this policy if she sees a strong combination against her, and may even unite with them to preserve the integrity of the Chinese Empire and the full meaning of the treaties. Japan, which must not be overlooked in the rating of commercial nations, is, fortunately, in line with the policy of America and England, and can be considered as a reserve force strengthening their position. Right at hand, in front of the very doors of China, she is an influence for good that must not be forgotten. She may be developing into an important competitor, but the more Japan develops, the greater seem to grow her demands for products of other countries, so that Europe and America have not yet cause for serious apprehension of Japanese competition. The new treaties coming into force in Japan, which make her for the first time in history a first class power in every respect, are destined to enlarge the field for the export of foreign products and for the investment of foreign capital.

THE FIELD IMPORTANT AND PECULIAR.

When I contend that China stands to-day with the greatest latent possibilities for foreign commercial, financial, and engineering exploitation, and that no part of South America or South Africa holds out such inviting opportunities, I mean that, while large portions of these continents may be undeveloped, wild, and possessed of splendid material riches, they have not the remarkable accompanying conditions upon which great trade and kindred movements depend for their immediate and

permanent growth. China, on the other hand, has nearly everything that tempts the exporter, manufacturer, promoter, financier, and engineer, which could be expected or desired in an extended expanse of new and undeveloped areas. Judged by certain standards, there could be great improvements of existing conditions in China, but were they already in operation, the field would be that much limited and not possess many of the novel and varied features which now make it so attractive. These manifold opportunities make China interesting and important to all who study her people and resources.

In the essential point of area, including that of all her dependencies, she is greater than the United States; in the more essential feature of population, which provides a great buying and selling force, she has four or five times as many inhabitants. It may surprise many of the readers of this article when I state in this connection that I believe, from careful study of the interior of China, that her population is greatly overestimated. I will not, however, enlarge upon this point, as I am saving it for specific and extended discussion. Sufficeth it to say that, even with considerable reduction in the present accepted figures, there are adequate millions in China to meet all the efforts of American and European achievement which will be devoted to them during the next two decades.

The field would not be so tempting were it small and the possibility of exploitation all known to the world after a few engineering and prospecting parties had traversed it in every direction. As it is, numerous individuals and groups of experts have repeatedly ventured into the interior—north, south, east and west—for the last quarter of a century, and yet our knowledge seems to be most limited. New plans are being framed every day for further study of the provinces and sections away from the treaty ports, and not a month passes that does not see a fresh expedition of engineers, prospectors, or government agents setting out from Hong Kong, Shanghai, or Peking. There is also a charm about the mystery of China's material wealth that fascinates the man who has in him any spirit of adventure, discovery, or of undertaking hazardous enterprises that may bring success or disappointment. There is a feature of gambling in this tendency to exploit China that appeals to the trust in good luck which all men possess in a degree. Enough, however, is known in positive terms to warrant what is being legitimately done.

POSSIBILITIES KNOWN AND UNKNOWN.

The invasion of China is not a wild chase into a desert, nor is it a search for the Garden of Eden. It is simply an eminently practical

movement based upon the best of reasons. Were China no larger than Siam or Corea, we would know now, with the amount of traveling and discovery that has gone on in the past, exactly what China has in store for foreign commerce, capital, and engineering skill. On the other hand, with China stretching away in all directions and covering over 4,000,000 square miles, these efforts have resulted in giving us merely a superficial and extremely limited idea of what there is in certain sections only. The larger part of China's possibilities remain yet to be stated in definite terms. What is known is ample evidence that the conclusions already drawn as to her latent wealth are logical, and they encourage without question far more extensive effort on the part of foreign interests. The world has been a long time in awakening to the opportunities of Cathay, but with the extraordinary appreciation which the events of the past year have aroused must come a proportionate determination upon the part of the nations most concerned not to allow the golden chance to be neglected.

In China's widest area, which extends 2,000 miles from south to north, or from Pakhoi to Kirin, and 2,000 miles from east to west, or from Shanghai to Batang and beyond, are found those immeasurable mineral and agricultural resources, partially developed or latent, which suggest mighty possibilities. There is that wonderful conformation of the earth's surface that permits of their successful development under modern conditions. Mountains and valleys, plateaux and lowlands, are found with that natural relationship which not only provides great river systems and means of inland transportation, but routes for artificial methods of conveyance and travel. Some of the deepest and longest streams of the world, with numerous tributaries, intersect China's richest areas. These in turn empty into, or are connected with, harbors which, in their frequency and excellence of location, provide the best ways of access to the outer world, and help to advance the interests of foreign commerce, both outgoing and incoming. The entire China coast line, winding in and out for nearly 2,500 miles, is dotted or indented with a marvelous succession of bays, inlets, and mouths of navigable rivers, that give her ideal facilities for coast and exterior commercial exchange by water transportation. Even after Great Britain, Russia, Germany, France, and little Portugal have had their pick of ports, there remain as many more, equally good, still in the hands of China—but coveted, I fear, by Austria, Italy, and Japan. Possibly the United States may be forced to look with longing eyes on some northern Chinese haven, if they shall wish to supplement their new territorial holdings in the south, and if they fail

to exercise the moral courage to keep China from her impending break-up. Should that possibility ever mature into a reality, let us trust that, to the honor and credit of the United States, the control of such a rendezvous for their ships of war and trade will only be secured by legitimate negotiation or treaty, and not by bulldozing tactics.

Now that America is a Pacific and Asiatic power with responsibilities equal, in some respects, to those of Great Britain, Japan, Russia, Germany, and France, she may find herself compelled to enlarge and protect her interests in many ways of which she now has no expectation, or of which she never dreamed in former years. May she have the mingled courage and judgment to get the best and avoid the worst in the conditions that confront her.

FOREIGN POLICY TOWARDS CHINA.

China is to-day the goal of a world movement. America and the great powers of Europe are all concerned in her industrial and political future as they are in that of no other land. But the present situation is so full of unrest as to be not only unsatisfactory, but threatening to the interests of those nations which supply the larger part of China's wants and provide a market for a considerable portion of her surplus products. Unless some mighty change is soon worked in the evolutions of politics at Peking, China will be divided. This is so evident that there is nothing gained by mincing words. The truth has been spoken often on this subject, but it cannot be repeated too frequently or too emphatically. Men, who like myself, have visited different parts of China, and especially the capital, are convinced that the only influence that can save this impending break-up is an understanding or combination on the part of the powers, which have more to lose than gain by this disaster, that they will use their united influences to prevent it. By references to understandings and combinations, I do not mean alliances sealed by treaties, protocols, or formal agreements, that might bring about unfortunate complications, but mutual purposes in policy, the achievement of similar ends, and the bringing of joint weight to bear where it would be invincible.

If this policy of exercising united influence would bring about war with Russia or any other prominent country with which the United States now has agreeable relations, it would not be popular; but such a contingency is out of the question. The strongest argument in its favor is the fact that it would prevent the possibility of war, or even talk of war. The united moral pressure of several leading powers will achieve the end without a suggestion of conflict, if it is once set in motion. Were the diplomatic agents at Peking of the United States,

England, Germany, and possibly Japan, once definitely informed by the foreign offices of Washington, London, Berlin, and Tokio, that they were to direct their efforts in unison to support the integrity of the Chinese Empire, maintain the open door and full freedom of trade according to the spirit and letter of the old Tien Tsin treaties throughout all China from Canton to Newchwang and from Shanghai to Chunking, the problem of China's future and of the interest of the nations named in China's development would be forever solved! With America, England, and Germany, supported by Japan, the countries which have the largest present and prospective trade in China, unitedly determined to prevent the division of the Empire and the infringement of the treaties by spheres of influence and discriminating duties, there would not only be an end to the quiet influences that are bending their energies to destroy the country's independence, but—what is of the greatest importance—there would be a broad, wide road opened for reform in China's central and interior government. The question of reform is always asserting itself in any discussion of China's future. China will never reform until the pressure from outside compels it. She has within her the elements of strength and virility yet remaining, if only they are brought into action, but they will never be utilized so long as foreign nations are weak and divided at Peking. On the other hand, let the principal powers show to China that they mean to protect their interests, not only by preserving the integrity of the Empire, but by compelling her to institute new conditions in the administration of law, justice, finance, and other important conditions of government, and they will witness the evolution of the new China and the passing of the old.

With this review of the politico-industrial situation I must rest for the present, reserving for a succeeding issue of THE ENGINEERING MAGAZINE the more detailed consideration of those material possibilities of the country especially interesting to the Magazine's constituency.

ECONOMY IN THE USE OF SUPERHEATED STEAM.

By R. S. Hale.

SUPERHEATED steam was thoroughly tried and tested about forty years ago both in America and in Europe, and, although it came into fairly frequent use, was finally discarded, in spite of the acknowledged economy, on account of practical difficulties. Of late it has been revived in Germany and France, with modifications that appear to have made it a practical success, and as its use will probably spread to England and America, the time seems opportune for a statement of the principles on which the economy due to the use of superheated steam depends, and for suggestions as to what type of steam plants may possibly profit from its use. In brief, we may say that for plants that are simply arranged—*i. e.*, with only a few engines, a few boilers, and a fairly simple system of steam piping—that are large enough to require a reasonably capable engineer in charge, and that run regularly, superheated steam, intelligently applied, appears to offer the opportunity for a considerable saving in coal.

1. The superheated steam may be produced in three ways, of which the first is to place the superheater in the flue where the gases will strike it after they leave the boiler. This will of necessity result in a small gain in boiler efficiency, since the heat put into the steam would otherwise be wasted. The amount of heat thus gained would not be over two or three per cent. in a boiler worked at ordinary rating, and the position of the superheater in the flue makes the amount of superheat very variable; for, if the boiler is worked easily, the temperature of the gases is only slightly above the temperature of saturated steam, whereas, when the boiler is forced, the difference of temperature between the gases and the steam increases much faster than the amount of steam to be superheated, so that the amount of superheat gained is very much greater.

While the installation of a superheater in the flue certainly saves a few per cent. of heat, it should be remembered that an economizer for heating the feed water would save more heat at less expense. With a superheater, the difference in temperature between the gases and the steam is only about 200 degrees; with an economizer, the difference in temperature between the gases and the water would be about 400 de-

grees, and the resistance of the surface to heat transmission would be very much less ; so that it is safe to say that a given area of economizer heating-surface would increase the boiler efficiency five times as much as the same area of super-heating surface, besides costing less to install, and less to keep in repair.

2. The superheater can also be installed in a separate furnace. In this case, of course, additional coal is burned, but additional heat is put into the steam, and it is theoretically possible to make a super-heating furnace that will be as efficient as a boiler, in which case there will be no loss in the total boiler efficiency. There are, however, practical difficulties in the way of an efficient furnace for separate super-heating, of which one is that the superheating furnace would be of small size compared with that of the boiler, and it is safe to say that, if a separate furnace is used for superheating, the total efficiency of production of the steam will be diminished.

3. The superheater may be placed in the path of the gases after they have passed over a portion of the heating-surface, but before they leave it finally. For instance, in a Babcock & Wilcox boiler a superheater may be placed between the tubes and the drum, between the first and second passes of the gases. In such a case the effect on the economy of the boiler is not immediately apparent. The gases, of course, give up the same amount of heat to the first portion of the heating-surface as they would if there were no superheater present ; they then give up a portion of their heat to the superheater. The heat given to the superheater goes to increase the total efficiency, but the giving up of this heat diminishes the temperature of the gases, so that the amount of heat given up by them to the remaining heating-surface is less than it would have been without a superheater. Careful analysis, of which it is unnecessary to give the details, shows that the net result is the same as that due to an increase of heating surface. For example, suppose a superheater of 500 sq. ft. heating-surface is added to a boiler, and suppose also that the superheating-surface offers twice as much resistance to transmission of heat as water-heating-surface does ; then the gain in efficiency would be exactly the same as if 250-sq. ft. of water-heating-surface had been added to the boiler. The percentage gain in efficiency on any particular day or test would vary as the boiler was forced or worked easily, and also as the air supply varied, but in every case there would be a slight gain. The gain in boiler efficiency for a superheater thus placed would be greater than that resulting when a superheater of equal area was installed in the flue, since, with the superheater in the flue, the gases could not be

reduced below the actual temperature of the superheated steam, while, with the superheater between the first and second passes of the gases, the gases, as they pass over the final portion of the water-heating-surface, would be reduced to a lower temperature. In addition, this position of the superheater makes the degree of superheat more uniform, and the superheater may be much smaller than if it were placed in the flue. Theoretically the best place for the superheater would be directly above the furnace, but this position is impracticable on account of the intense heat.

It should be noted, however, that an increase of boiler heating-surface in comparison to the work done will in every case increase the boiler efficiency to as great extent as a superheater will, and an economizer will increase the boiler efficiency more than a superheater will, while the expense of installation and maintainance of either boiler heating-surface or economizer heating-surface is at present much less than the expense of installation and maintainance of the same effective area of superheating-surface.

We come now to the second division of the subject, the losses in the steam pipes in the transmission from the boiler to the engine. These losses consist of radiation, fall of pressure, and leaks, and in the case of radiation the loss is increased in direct proportion to the amount of superheat. This is the case even when the steam is so superheated that there is no condensation in the pipes, since, if the steam starts dry at the boiler and loses heat by condensation, the actual loss is nevertheless smaller than if the steam starts superheated, and loses a part of its superheat as it passes to the engine, the heat lost being in proportion to the temperature of the pipes, whatever the condition of the steam inside.

The second loss in the steam pipes is due to fall in pressure, which depends on the velocity of steam; and, since superheated steam takes up greater volume and hence moves with greater velocity than saturated steam, the fall in pressure will be greater in pipe of the same size, while, if larger steam pipes must be provided, greater radiation losses will occur. This is true whatever size of pipes be used; but it seems to me that a great majority of plants use too large pipes. The steam pipes close to the engine must be large, otherwise the pressure falls during admission to the cylinder; but, if a large steam pipe or steam reservoir be provided close to the engine, of sufficient size to keep up the pressure during the admission period, then (for an engine cutting off at one-quarter stroke) the steam pipe from the boiler to this reservoir need be of only one-quarter of the area or one-half the

diameter usually used. The writer has often seen a 12-inch main with 6-inch offset pipes, leading to the engines, and wondered whether a 6-inch main with 12-inch offsets to the engines would not give a higher initial pressure on the indicator card. Still, whatever size of pipe or arrangement of sizes be used, the fall of pressure and consequent loss would be greater for superheated steam than for saturated steam of equal weight.

The third loss from steam pipes is from leaks, and most engineers, even those who make carefully the ordinary tests of their plants, will be surprised to find out how much steam actually leaks away, even if the joints appear staunch and tight. The following figures show the results of tests of plants.

Leakage in per cent. of useful steam, assuming plant to be worked steadily to its full capacity :

Mill	5	per cent.
Mill	16	per cent.
Electric Plant.....	7	per cent.
Electric Plant.....	2½	per cent.
Steamship	1½	per cent.
Steamship	6	per cent.
Steamship	10	per cent.
Waterworks	2½	per cent.

If the plant is kept under steam but worked only one-half its capacity, the percentage of the useful steam lost in leaks would be doubled. If the plant is worked one-third its capacity the percentage would be tripled, and so on. Thus the electric plant No. 3 in the above table, working at an average of one-third its capacity, lost 21 per cent. of the steam actually used.

I know of no leakage experiments similar to these made in plants using superheated steam, and can therefore do no more than estimate the probable results. If the temperature of superheat remains uniform, the leakage need not be much greater than the leakage with saturated steam; but with saturated steam the variations in temperature of the pipes are only slight, except when steam is shut off, whereas with superheated steam not only is the total change in temperature when steam is shut off very much greater, but the temperature of superheat and the temperature of the pipes is changing every hour and every minute, and often to a considerable degree. Now, since the leaks in the steam pipe lines are due generally to expansion and contraction caused by changes in temperature, it is safe to estimate that the leaks in a line of steam pipes carrying superheated steam, which has greater

changes in temperature, will be considerably greater than those from a similar line carrying saturated steam, both lines being looked after with equal care.

Finally, we come to the engine; and here we find a clean net saving which, in the case of a high degree of superheat, may amount to from 10 to 20 per cent. The difficulties at the engine are only the question of lubrication, which seems to be satisfactorily solved by the liberal use of some of the heavier mineral oils. There is, of course, considerable difference between different engines, depending largely on the valves. Vertical engines with poppet valves will give least trouble, while horizontal engines with unbalanced slide-valves will require the greatest care. Recapitulating, we find for superheated steam:

1st, a slight gain at the boiler, although a less gain than that can be obtained by increasing the boiler heating-surface, or by the use of an economizer.

2d. An increased loss in the steam pipes, due to the increased radiation, fall of pressure, and increased leaks.

3rd. A large gain in economy at the engine.

It is obvious that the sum total of these results will be very different in different plants, and even in the same plant may vary according to the way superheat is produced, and its amount.

In regard to the kind of superheater, the analysis above given has shown that the use of a superheater between the first and second passes of the gases gives a little greater economy than either of the other methods suggested as an alternative. This method also permits the use of a very much smaller superheater than is required when the superheater is placed in the flue, and gives a much steadier and greater amount of superheat; it is this type of superheater that has come to the front in Germany and France as a practical form. Since the smaller area of superheating surface here required diminishes the first cost, and also the cost of maintainance, we find that both theoretical and practical considerations indicate that, if a superheater be used at all, it should be placed in this position. A still further advantage for this position is that it leaves place for an economizer in the flue, while with a superheater in the flue there might be no room for an economizer. The superheater in a separate furnace gives less power economy, and costs more, but may possibly be useful in one particular case which is as follows: If the distance between the boiler and engine is very large, then if superheat is produced at the boiler, it will have almost or entirely disappeared at the engine, and there will be little or no economy. If, however, a superheater is placed in a separate fur-

nace, close to the engine, then the full saving due to superheat may be realized and this advantage may more than offset the cost of the separate superheater and furnace.

In regard to the degree of superheat, it is obvious that if superheaters are used the full advantage should be taken. The cost of installation and cost of maintainance of a superheater are only slightly greater if a high degree of heat is obtained than if the steam is superheated only slightly, while the saving in coal increases to a very great extent. The indications are clear, therefore, that as high a temperature as practicable should be used. And it should be noted that the modifications over ancient practice which appear to have made superheat a practical success abroad are placing the superheater between the first and second passes of the gases and the use of a very high degree of superheat. Now, with a superheater placed between the first and second passes of the gases, giving, say, 500 to 700 degrees F. temperature of the steam, with a small amount of piping, with the plant worked all the time, we have:

Gain at boiler.....	2	per cent.
Gain at engine.....	10 to 20	per cent.
Extra loss in pipes, radiation, say.....	1	per cent.
Extra loss in pipes leaks, say.....	3	per cent.
Extra loss in fall of pressure, say.....	$\frac{1}{2}$	per cent.
Net gain.....	$7\frac{1}{2}$ to $17\frac{1}{2}$	per cent.

Such a gain in annual coal bill would probably be enough to pay for fixed charges and maintenance of superheater. On the other hand, suppose there is double the amount of piping, and that the plant averages only one-third as much net work; we then have:

Gain at boiler.....	2	per cent.
Gain at engine.....	10 to 20	per cent.
*Extra loss, radiation.....	6	per cent.
*Extra loss, leaks.....	18	per cent.
Extra loss, fall of pressure.....	$\frac{1}{2}$	per cent.
Net loss $2\frac{1}{2}$ to $12\frac{1}{2}$; of course, superheating will not pay.		

It should be noted that if it pays to equip part of the boilers of a plant with superheaters, it will pay better to equip them all. If only a part of the steam is superheated, then some of the superheat serves only to dry out the moisture in the rest of the steam and has no effect at the engine, whereas, if all the boilers have superheaters, all the superheat is effective in improving the economy and none is wasted.

* Double the loss divided by one-third as much work done, making percentage six times as great.

THE DEVELOPMENT OF GERMAN SHIP-BUILDING.

By Rudolph Haack.

II. THE SHIP-YARDS ON THE NORTH-SEA COAST.



BELL-BUOY.
Aktien-Gesellschaft Weser.

IN reading the short review of the history of evolution of German ship-building, which formed the initial paper of this series in the July issue of *THE ENGINEERING MAGAZINE*, the question must arise: How could development so remarkable be attained in a time relatively so short? England and France had begun much earlier to build iron-clads and torpedo-boats, and the experience of the English engineers in designing and building fast and elegant transatlantic passenger steamers was much older and fuller than that of their German rivals.

To give a general answer to this question is the principal object of this second article, and, first of all, it must be cordially admitted that the British ship-building has served from first to last as a splendid model, which the Germans have not hesitated to use on the greatest scale. Many German naval and mechanical engineers



CHINESE PROTECTED CRUISERS HAI YUNG, HAI SHEW AND HAI SHEN.
Length, 315 ft.; beam, 41 ft.; depth, 24 ft. 7 in. Mean draught, 16 ft. I. H. P. 8,400 at a speed of 20.75 knots and displacement of 2,950 tons. Built at Stettin, 1897-98.

held positions in the largest British yards, thus adding to their knowledge; others made frequent trips across the channel to study the equipment and organisation of British workshops. Much of the heavy handling-machinery and many of the machine tools were bought in Britain. It is a pleasant duty to admit that, without Britain as a teacher, no such rapid success could have been attained.

The already mentioned ship-building institution near to Stettin was very early merged in the Gewerbe Institut of Berlin, and at the latter place the number of lectures and their intrinsic value greatly increased. A second forward step was made when this institute was developed into the existing Technical High School at Charlottenburg, in which the students who are enrolled in the division for ship- and marine-engine building are to be counted by hundreds.

Young men with preparatory technical training go from this school into practical work, and if, as is the case with many of them, they have any desire to acquire that practical knowledge not obtainable at a school, they are very soon fitted to fill the highest and directing positions in large ship-yards, to the profit not only of the works employing them, but also to their own profit and to that of the national industry of ship-building.

Theoretical training is to be had also in the many special technical schools, and in these are trained those who do not aspire to the highest positions in the largest machine shops and ship-yards. The many training schools founded in the shops and yards, by the school boards of many cities, have a great and good influence on clubs, workmen, and apprentices, and thus better, cheaper and faster work is secured.

It is not so easy to determine quickly the exact share that the different yards have had in the general development of the whole. They have done much to develop practically engineers, constructors, designers, foremen, and workmen; they have organised and built up yards and machine shops; they have utilised existing facilities and materials, and an opinion can only be reached by a short description of the ship-building yards, their origin and their present capacity; in this manner the differences between them, as well as the common striving of them all for one great national perfection, can be recognised.

Mention has already been made of the three great yards of the Imperial navy, of which the oldest at Danzig has remained the smallest, because the city has been given up as a war harbour since the selection of Kiel, much better situated with reference to the whole



CHINESE PROTECTED CRUISER NAN THIN, BUILT AT HOWALDTSWERKE, KIEL.

Length, 253 ft.; beam, 36 ft.; draught, 18 ft. Displacement, 2,200 tons. Indicated horsepower 2,400, at a speed of 14.2 knots.

Baltic. Therefore the yards at Danzig were devoted principally to the building and repair of new cruisers and small vessels, especially as there were no facilities whatever for the shaping and handling of heavy armour.

The naval works at Kiel and Wilhelmshafen consists of great harbours for the iron-clad fleets of the Baltic and North Sea, and in these extensive dockyards there are stores of munitions and weapons and other war materials, as well as a great number of ships and machine shops for new work and repairs of men-of-war of every kind.

A special description of the organisation and arrangement of these works is not permissible; but it can be said that they are technically directed, in charge of and under the management of naval and mechanical engineers who are graduates of the high school at Charlottenburg, who further perfected their knowledge in the Government yards, and in other German and foreign yards.

To recruit skilled labourers in large numbers was at first a problem of extreme difficulty—especially at Wilhelmshafen, an entirely new place. They had to be coaxed there from other ship-building cities by all sorts of premiums and inducements in the way of dwellings, supplies, wages, etc. Now there is a large force of workmen on hand,

quite sufficient for usual requirements, but easily capable of increase in numbers in special cases.

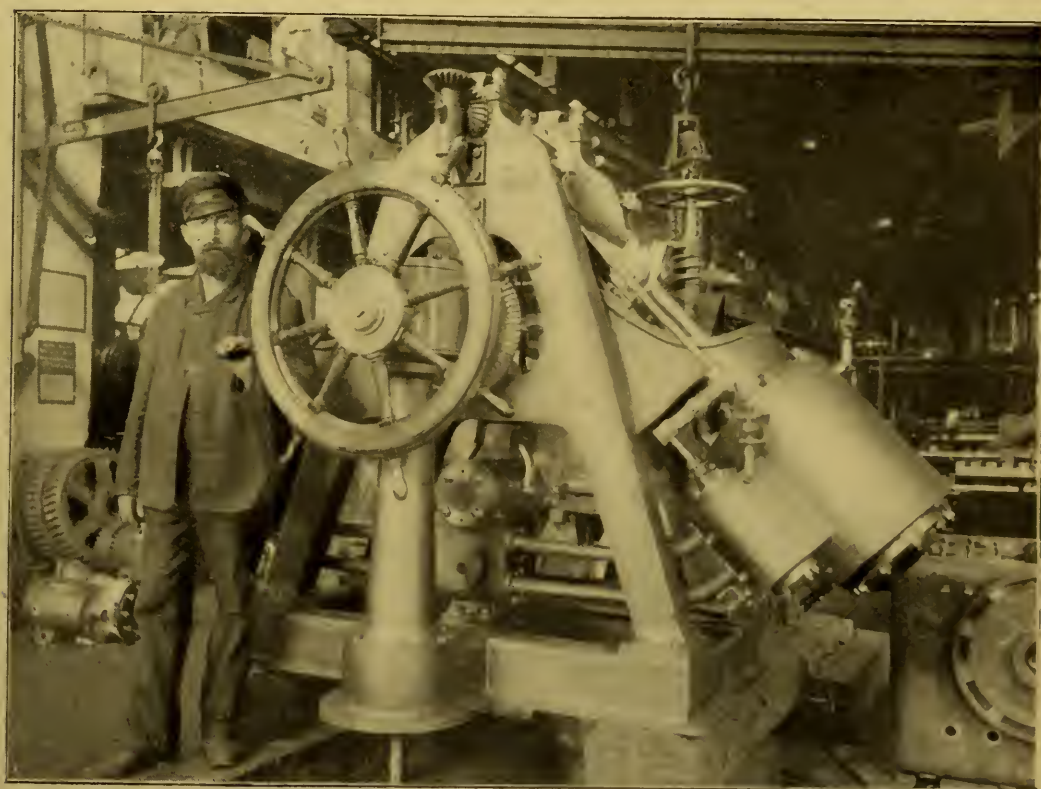
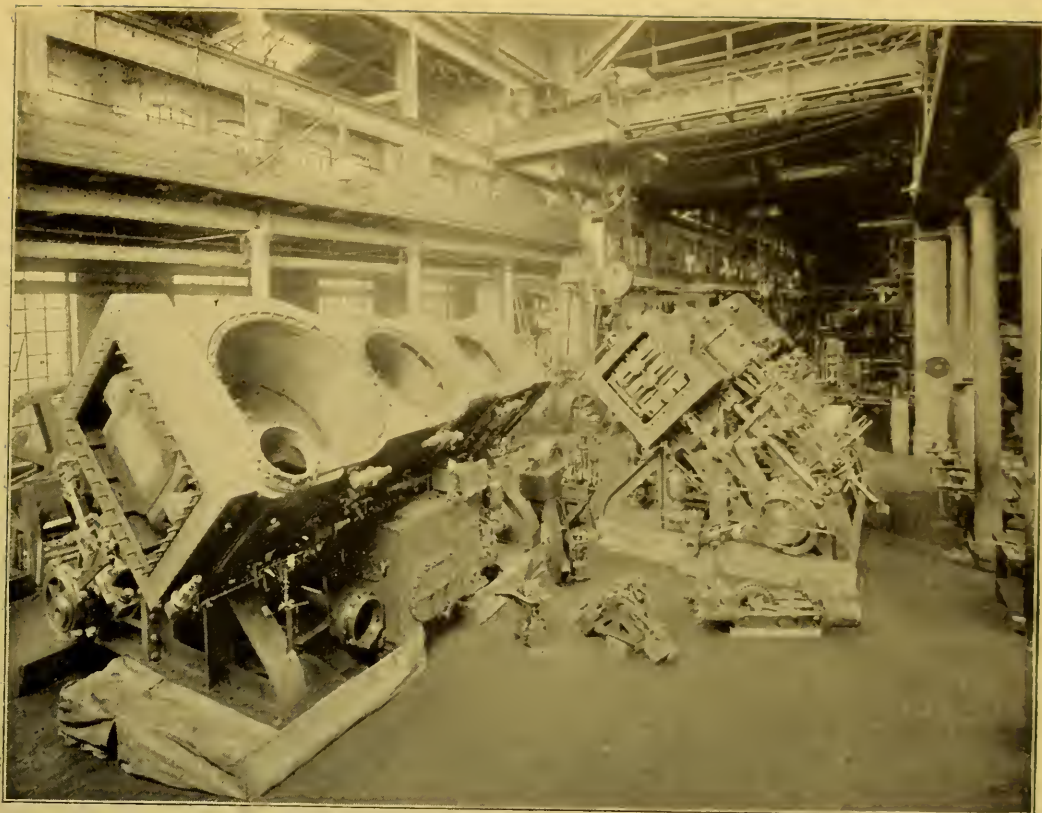
The products of these three great yards in men-of-war of all kinds, built from plans and specifications furnished by the Imperial Admiralty Bureau of Naval Construction in Berlin, are equal to the best in any foreign land, and in performance they have in recent years shown constant betterment.

Private yards, busy for the most part with merchant steamers, but also with war vessels for the German navy, have recently increased very greatly both in number and size. For sea-going vessels there are not less than forty-nine yards, of which thirty are on the coast of the North Sea and nineteen on the shores of the Baltic. In addition there are seven yards on the Rhine and in Westphalia, and three on the Elbe, which build boats principally for river and canal traffic, but also undertake to deliver smaller vessels, suitable for coast trade.

Beginning at the western boundary of Germany, the first yard is that of Jos. L. Meyer, in Papenburg, founded in 1872 by its present owner. It began on iron ships, and soon added those of steel up to 1,000 tons displacement with the necessary engines. It also builds smaller vessels for sea and river traffic. The capacity of the yard is about 1,350 to 1,750 tons annually, with engines from 306 to 1,570 i. h. p.; the yearly turnover is about 700,000 mk. In addition to ship-building it also constructs dredges and hopper-barges. The largest steam engine is 400 i. h. p. The yard covers an area of nearly $7\frac{1}{2}$ acres. It employs an engineering staff of twenty-three to design and construct the vessels, the manager being Mr. Jos. L. Meyer himself. The number of workmen last year was four hundred.

This yard, although one of the smallest, has steadily grown and done work so excellent that the Imperial navy prefers to honour it with orders for smaller vessels and craft, and in addition the Imperial Government has already ordered several steamers, now finished, for the African colonies.

After this come, in the order mentioned, four yards in Emden, Spiekerhörn, West-Rhauderfehn, and Oldenburg, which thus far have not attained great importance; but the next one, the Aktien-Gesellschaft "Weser" in Bremen, has long been of great importance. It was founded by Carsten Waltjen as early as 1844, and at first limited its work to castings, steam-engines, and a few wooden river steamers. The present company took over the business from the founder in 1872, and since then it has been busy with war vessels, as well as passenger and freight steamers for ocean and inland waters. In the work year



MARINE ENGINES AND STEAM STEERING ENGINES. AKTIEN-GESELLSCHAFT WESER, BREMEN.

1897-1898 about 9,800 gross tons with 11,500 i. h. p., were delivered with a turnover for the plant of 4,000,000 mk. The staff, now directed by Messrs. Gleim, Graf, Zeltz, and Unger, having charge of construction as well as management, consists of sixteen naval constructors, thirty-two mechanical engineers, and eighty-nine foremen and employees. The workmen numbered 685 in 1872-1873, but have increased to 1,772 for the last year. The principal yard is on the Weser, with a repair shop and dock at the free port, and the whole plant covers an area of nearly 9 acres.

In addition to vessels of all kinds the "Weser" makes dredges, cranes, hoisting appliances, and stationary steam-engines, while the foundry supplies large castings of iron and bronze.

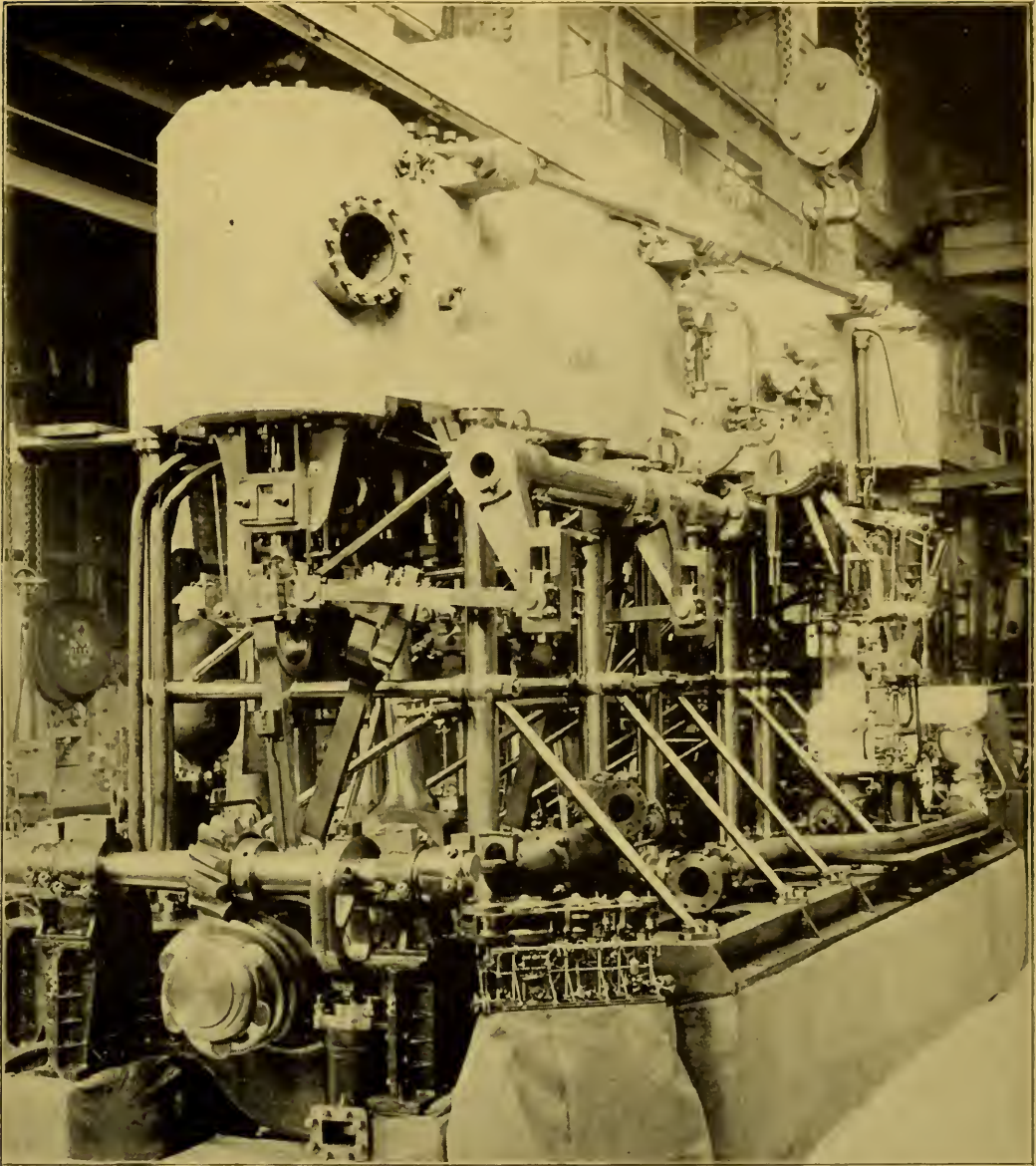
As already mentioned, these yards have built a number of war-ships for the German navy and for foreign powers, and thus gained great experience in this field as well as in the building of merchant ships. Its products are rated among the best in the whole of German ship-building.

From the combination of several old yards for wooden ships there was formed near Bremen the "Bremer Vulkan" Schiffbau und Maschinenfabrik-Vegesack, a plant that in the short time since its organisation has been uncommonly active and has made noteworthy progress. Its yards cover about 5 acres, and there is place for ten ships on the ways at once.

The building of steam and sailing ships for high-sea fishing was



FIG. 1. SHIP BUILT BY THE ARSENAL OF THE WESER.

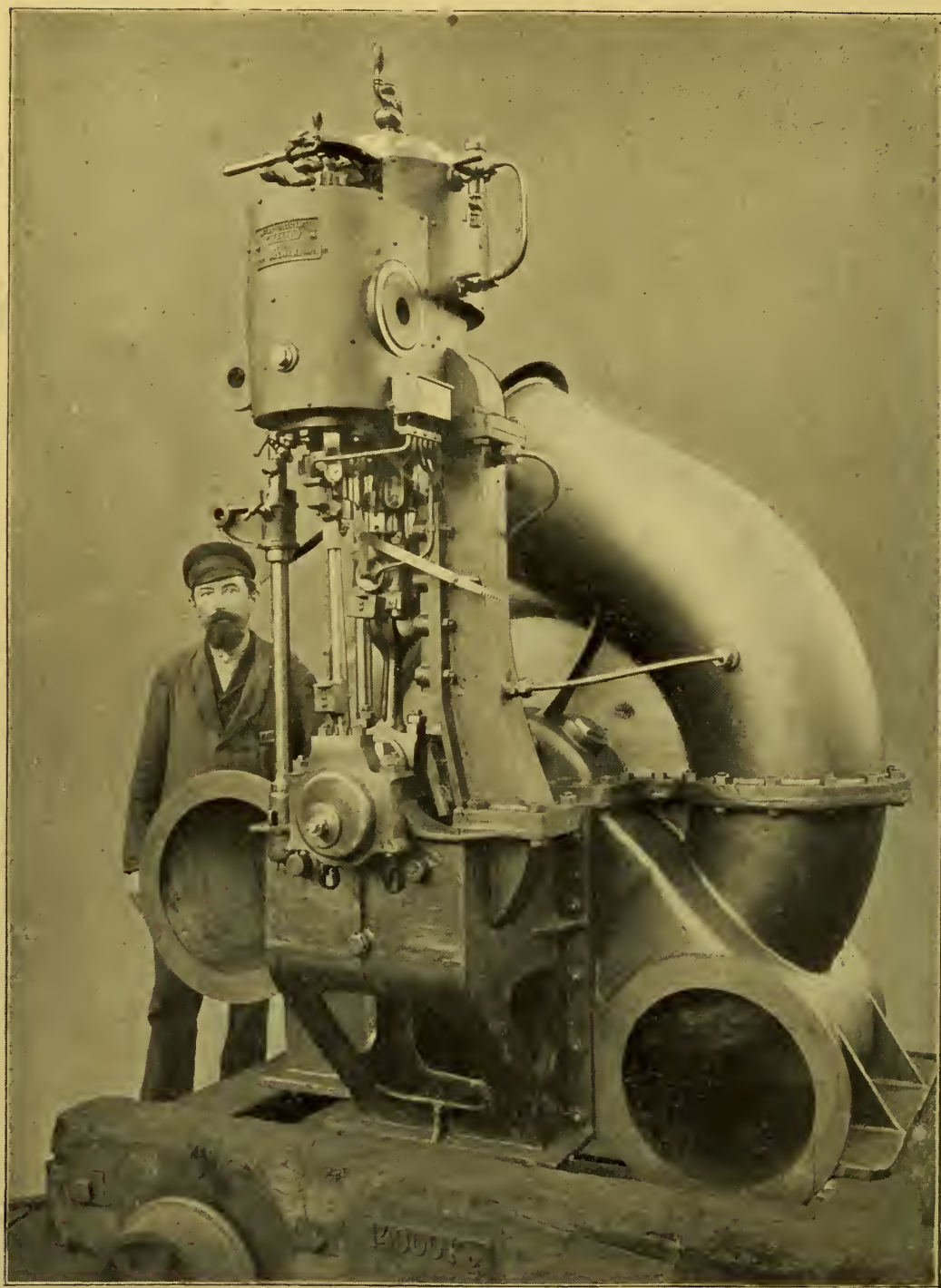


BATTLE-SHIP ENGINES CONSTRUCTED AT THE AKTIEN-GESELLSCHAFT WESER, BREMEN.

at first the principal occupation, and yielded good profits, but very recently they have begun building large freighters and oil tankers. At the beginning of this year two steamers, each of 5,000 tons gross, for the North German Lloyd, and eleven other large and small ships were on the ways. For all of these, including five just delivered, the gross registry was 21,686 tons.

Since organisation under the present management the Bremen "Vulcan" has earned good profits. It declared dividends of 10 per cent. to its shareholders in each of the years 1896 and 1897.

Further down the Weser, in Hammelwarden, is a little yard build-



A STEAM CENTRIFUGAL PUMP.

ing wooden and iron ships of small size; in Brake there is a second yard of the same kind; then comes in Geestemünde the important plant of the Joh. C. Tecklenborg Aktien-Gesellschaft, founded by Joh. C. Tecklenborg in 1840 in Bremerhaven. He built wooden sailing vessels

in the yard up to 1879, and then iron sailing vessels and steamers, the engines being ordered elsewhere; but in 1891 the new company began building its own engines in its new machine shops. They are thus wholly independent, and can deliver large freighters or sailing vessels, of which one, the largest in the world, the "Potosi," bark rigged with five masts, deserves special mention. This vessel is 365 ft. long, 49.6 ft. beam, and 31.3 ft. hold; it measures 3,854 net tons, and was built in 1895 for the house of F. Laeisz, of Hamburg.

Ship yard, machine shop, dry-dock and marine railway cover an area of 18 acres, and are so skillfully situated on the Geeste, a small

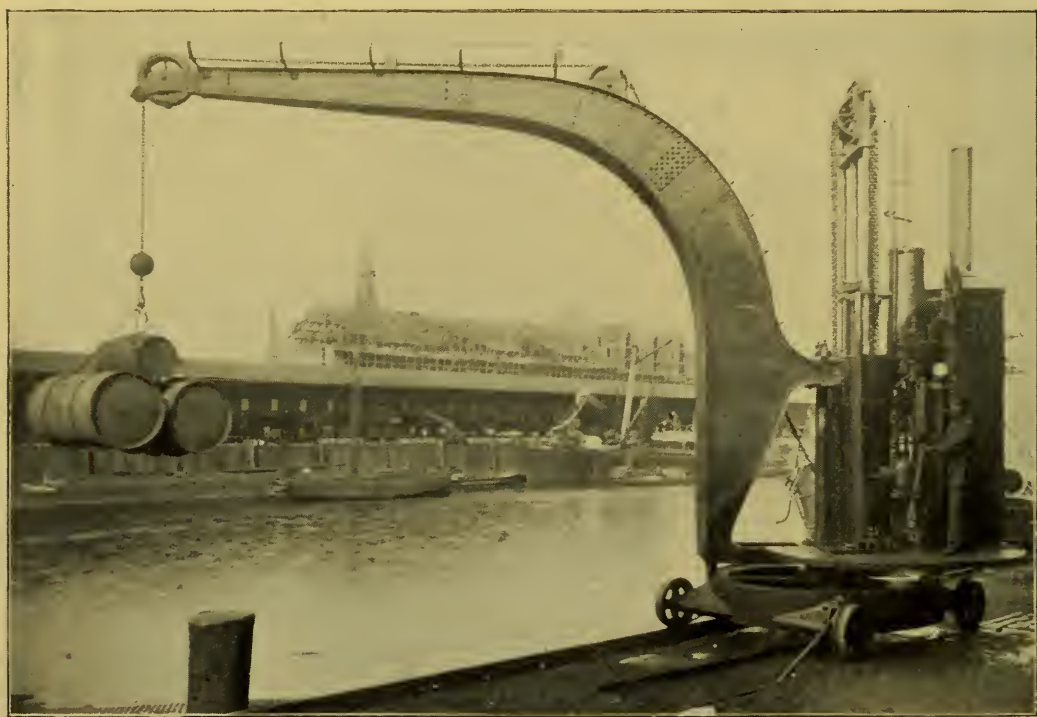


FLOATING SHEARS OF 85-TONS CAPACITY.

Built by the Aktien-Gesellschaft Weser, Bremen, 1887.

tributary of the Weser, that the building and launching of ships of the above dimensions is possible. Thus far no war vessels have been built here, but a number of merchant vessels, both sail and steam; and activity has so much increased that against 4,340 gross tons delivered in 1890, in 1898 not less than 10,105 gross tons complete, with engines of 5,100 i. h. p., were finished, the cash turnover being, at the end of that year, close to 2,500,000 mk.

The general manager is Mr. George W. Claussen, who has under him a staff of eleven naval constructors and fourteen mechanical engineers, besides forty-seven other foremen and clerks. Last year nine hundred and eighty-one labourers were employed as against eight hundred and fifty-five in 1890. There were foreign orders at these yards for two sailing vessels and ten steamers, a total of 10,800 gross tons and 5,500 i. h. p. Besides ships the company builds oil tanks, sluice-gates, feed-water filters, patent ribbed tubes for boilers, etc. The well merited reputation earned by this yard has been built up largely by the splendid design and careful execution



WHARF CRANE, BUILT IN A BREMEN SHIP-YARD.

of the ships ordered, and it now occupies a leading place among German ship-building yards.

Immediately adjoining the above yard and also on the Geeste lies the yard of G. Seebeck, Aktien-Gesellschaft, whose rise has been very

rapid; it is well deserving of recognition. Last year it delivered nine ships of a total of 4,000 net tons, one of these being of 1,988 tons for the North German Lloyd. The ships delivered and on the ways in the early part of 1899 measured a total of 9,709 gross tons. This firm



TRANSPORTING THE WESER LIGHT HOUSE TO ITS POSITION.
The tower is being floated to its place between two pontoons.

not only builds new ships, but has also an extensive repair business, a profitable branch, and they make use of a dry dock dating from an earlier period.

There is yet another yard at Geestemünde on the Geeste, that of the Rickmers-Reismühlen, Rhederei und Schiffbau Aktien-Gesellschaft, which builds freighters, both sail and steam, for the rice trade of the firm, and also fills orders for others. The vessels delivered and still on the ways at the end of 1898 measured a total of 9,506 gross tons. This yard is not a new one, and was formerly very active on wooden ships, but recently there has been marked increase in vessels of iron and steel.

The yard of F. W. Wencke in Bremerhaven is principally busy

with small vessels. Last year, to January, 1899, five steamers were on the ways, with a total of 650 gross tons. The principal business is, however, repairs and for this purpose the yard uses a large dry dock.

Turning now to the Elbe, we reach Hamburg, the most important sea-port in Germany, whose commerce and trade have in recent years so increased that the city rivals the largest in the world. In the old days of wooden ship-building there was great activity in Hamburg yards, but all this has died out and, since iron has supplanted wood, is limited to repairs. Only one large yard, the Reiherstieg-Schiffswerfte, founded in 1863 by the president of the Hamburg-American Packet Company, Mr. Godeffroy, undertook to build iron ships on the



FLOATING DOCK OF THE AKTIEN-GESELLSCHAFT WESER. BREMEN, 1886.

Elbe, and this without very great success. In those days all big orders were captured in England, and only in 1873 did the Reiherstieg build the first two steamers for the company, each of 938 gross tons, an order considered important in those days compared to the little orders for harbour boats which had thus far been given. A better business was done in repairs, which were constantly increasing and yielding good profits, and these assured the continued life of the yard.

Early in the eighties this yard was taken over by a joint-stock company and the increase of working capital obtained at that time permitted great improvements in, and addition to, the work shops and

their equipment. In this way it was possible for this yard to undertake the construction of the already mentioned Rhätia, and to secure, among other equipments, a big floating dock. The latter permitted repairs of larger vessels, and orders for new construction increased in both number and size, one freighter built here having a registry of 8,500 tons; the cruiser Marie, for the Imperial German navy, was also built in this yard. It ranks as the first in time in the regeneration of modern flourishing German ship-building.



FULL-RIGGED NORWEGIAN SHIP WINNIPEG.

Vessel of 1,303 gross tons in the Swentine dock at Kiel, 1890.

It is only in a large commercial city like Hamburg that a yard like that of Blohm and Voss, Kommanditgesellschaft a/Aktien, could attain in so short a time the prosperity it now enjoys. The men whose names appear in the firm title are founders, part owners, and managers. Provided with abundant means, they established in 1877 in Steinwärder, on the left bank of the Elbe, a yard splendidly equipped from the very start, to build ships and engines, from that time to this they have aimed to surpass all other German yards in both size

and capacity. At first they were busy with orders from merchant vessels and with repairs, and for the latter purpose secured several floating docks, one of 17,500 tons capacity. More recently Blohm and Voss received orders to lengthen three large mail steamers of the North German Lloyd, and this was rapidly and satisfactorily done. Seventy feet were added to the length while the steamers were in the big floating dock, a totally new experiment in ship-building practice. The Imperial navy had already given this firm several small orders, but recently honoured them with the contract for one of the largest armoured battle-ships; for the merchant service this firm built the well and favourably known freighters *Pennsylvania* and *Pretoria*, each of 12,800 gross tons register, with engines of 5,000 i. h. p. These two steamers are among the largest in the world.

In this great establishment one sees the manifold advantages to be obtained from a systematic plan of workshops and ways. Everything was ordered and built in accord with the original plan, every new experience utilised, so that the whole, completed in harmonious perfection, permits rapid, thorough, and very profitable work. In addition, there is never any lack of work in Hamburg under normal conditions; there are also auxilliary supply depots and trades in great number. Wages are indeed very high, but this leads to installation and steady improvement of automatic machinery, etc., and thus the disadvantage of high wages is equalised.

A neighbouring but smaller yard is the *Schiffswerft und Maschinenfabrik* (formerly Jansen & Schmilinsky) *Aktien-Gesellschaft*, busy chiefly with orders for small vessels. Founded by Jansen & Schmilinsky, it was taken over by a joint-stock company in 1888 and is to-day managed by Mr. Thulesius. The area of the yard is a little less than $2\frac{1}{2}$ acres, and its chief business is the building of small passenger, freight, and tug boats, and lighters, and the repairing of vessels and engines. The greatest length of vessel finished by this firm is 158 feet, and the largest engine built about 400 i. h. p. During the last ten years a gross annual tonnage of 555 to 750 was turned out and the engine powers ran from 1,600 to 1,750 i. h. p. The yearly turnover reached in 1897 700,000 mk., of which five-sevenths was new work and two-sevenths repairs. The work was done under the management of seventeen engineers, foremen, and officers, and three hundred and fifty workmen. On foreign orders this little yard has already supplied one hundred and twenty-three vessels of a total of 5,000 gross tons and 6,570 i. h. p. Among these orders were several for the German colonies in East and West Africa. The firm has a

high reputation for this kind of boat and constantly secures new orders.

Another yard, B. Wencke Sons, was started by Mr. B. Wencke in 1847, and in 1858 James Empson & Co., who added a machine shop, joined the firm. Until 1876 only wooden ships were built, but since that time small cargo boats, fishing steamers, tug boats, etc., have been constructed. The output rose from 30 tons with 75 i. h. p. in 1890 to 240 tons with 570 i. h. p. last year. Two engineers and eleven foremen and officials have positions in office and workshops, in which such other work as steam boilers, tanks, and pontoons is also undertaken. The firm is mainly occupied with numerous repair orders, and is well equipped with a dry-dock, a marine railway, and several slips. The area of the yards is a little less than $5\frac{1}{2}$ acres.

In the smaller Hamburg yards the building of new ships is generally a secondary consideration and merely serves to give employment to a pay roll of efficient workmen, who at all times must be ready for the rapid and also very profitable repair work. This is especially true of the yards of Heinrich Brandenburg, equipped chiefly for repair orders, founded in 1843 at Steinwärder and occupied until 1873 with building wooden vessels. For modern repairs, with which it is mostly busy, this firm has a large floating dock of 3,600 tons lift, a marine railway, etc. The management and pay roll comprises three naval constructors, five mechanical engineers, twenty-two foremen and office force, and the number of workmen rose from three hundred in 1890 to eight hundred in 1897. New orders are for small steamers only. The area of the yard is about 3 acres.



NORTH GERMAN LLOYD TWIN-SCREW STEAMER FRIEDRICH DER GROSSE.

Length, 525 ft.; beam, 60 ft.; depth, 38 ft. Displacement, 10,536 tons. Speed, 16 knots
7,500 indicated horse-power. Built by the Vulcan Works, 1896-97.

There are also other small yards, that of Wichorst and that of H. C. Stülken Son, the former building twenty-nine steamers, tug boats, and lighters, a total tonnage of 4,590 gross, and the latter twenty-two small vessels and boats, a total of about 589 gross tons. Also near Hamburg, in Harburg, the firm of Holtz, founded many years ago, builds steam pleasure-launches and other small steamers both for home and abroad. The yards with machine shop cover about $4\frac{1}{2}$ acres and give employment to four hundred workmen, who build the little boats and everything appertaining to them.

On the shores of the Elbe, at Hamburg, and below toward the sea, as well as on the west coast of Holstein, there are a number of little yards busy on small steamers and sailing vessels, but a mention of their names must be sufficient. In Neuhof on the Reiherstieg, the yard of G. Wolkau, in Cranz that of I. Sietas, in Glückstadt that of J. & H. Gehlsen, in Wewelsfleth those of J. Junge and J. Peters as well as that of I. C. Wriede in Finckenwärder, in Tönning that of Schömer & Jensen, which in 1898 built eight little vessels with a total of 1,132 gross tons register, and finally the yard of Johs. Thormälen & Co., in Elmshorn.

All these little yards merit mention for their help in the great national work of German ship-building, as they add to experience, train workmen, and also because they are themselves growing in importance.



SYSTEMS FOR THE REMUNERATION OF LABOR.

By P. J. Darlington.

IN the June number of THE ENGINEERING MAGAZINE I presented a general discussion and comparison of plans for remuneration of labor. The conclusions were unfavorable to the premium plan, and Mr. F. A. Halsey replied in the *American Machinist* of June 22nd in its defence.

A careful study of this reply does not discover any defects in my previous treatment, which it is now proposed to confirm and illustrate more fully in answer to Mr. Halsey's objections. Mr. Halsey claims that piece work is wrong in theory and a failure in practice; that he has discovered a good system in a combination of piece pay and time pay, which he calls the "premium plan." He urges manufacturers to throw out piece work and substitute this system.

I contend that the claims of the premium plan are founded on false assumptions; that piece pay alone is more direct and effective under all conditions; that piece work is suited to its purpose, and has failed only when misapplied through ignorance of its principles; and that the premium plan cannot accomplish the best purposes of piece work.

In making a detailed study of plans for remunerating labor, we must get a clear idea of their purposes and means available, define the terms to be used in the discussion, review the characteristics of each plan, and, finally compare their effects on manufacturing economy.

In general the cost per piece of product is made up of two elements:

1st.—Product expenditures, consisting of the wages paid to the operator per piece produced ("wages cost"), and the material actually entering into the product, together with that maintainance and operation which is dependent on the number of pieces produced, as, for example, additional power to drive an increased cut, renewal of dies for drop forgings, royalty on designs.

2nd.—Plant expenditures, or those charges which must be made against each piece of product to cover interest, taxes, insurance, depreciation and maintainance of property, and those fixed general operating costs which are annual expenditures and independent of the productiveness of the plant. We will call this cost per piece "equipment cost."

The purpose of all plans for remuneration of labor is to reduce the total of these two piece costs and maintain the smoothest possible operation of the works and highest quality of product.

Two pay elements are available for remunerating labor :

1st.—Time pay, based upon a day rate or arbitrary time value assigned to each worker regardless of the product of his labor.

2nd.—Piece pay, based upon the amount and quality of product regardless of the individual worker and expressed in a piece price. This piece price may be either fixed or dependent on the speed of production ; it may be increased or decreased (by a "change factor") when the speed of production has reached a fixed point ("change limit"). This change of price may affect all of the pieces on the contract, or only those turned out after passing the change limit.

This gives a number of sub-divisions of piece pay, several of which have been used in manufacturing works. "Piece work" is piece pay in which the piece price is fixed and independent of the speed of production. "Reduced piece work" is the result of reducing the piece price (on additional pieces only) when the speed of production reaches a change limit.

In the "Taylor differential piece-rate" system, the piece price is at first very low, but when the speed of production has reached a high predetermined change limit, the piece price is raised on all pieces in the contract, provided that the workmanship is strictly first-class. If, however, the workmanship is inferior but passable, the piece price remains at the very low value. This results in a higher average pay per piece, the faster a worker produces and the better the quality of his product.

The "premium plan" combines two elements :

1st.—"Liberal" time pay to a low limit of speed of production (full day pay for less than a day's work), with the promise that this low limit shall be set from actual shop results and records.

2nd.—Reduced piece work, or less than proportional piece price on the additional pieces only.

In this system the faster a worker produces the lower his average pay per piece.

Piece work pays for the acceptable product only, thus enforcing wage penalty for failure in amount or acceptability. Day work pays for the time that can be spent on the work. The Taylor differential piece-rate system pays for the acceptable product, with a special reward for quick and perfect work, and a special wage penalty for slow production and for inferior, even though acceptable, workmanship.

The premium plan pretends to pay in part for the work done, but offers a reward for doing it slowly, and full day pay for doing it not at all or not acceptably.

Otherwise stated, if we assume an increase of speed of production, in piece work the worker is given the saving in wages cost, while the employer takes the saving in equipment cost with the additional profits due to increased plant output. In the Taylor differential piece-rate system the employer establishes an additional reward and penalty as extra incentive to increase the output and the quality. In the premium plan the employer demands all the equipment saving, increased profits, and most of the wages saved in addition. Yet the premium plan is presented by its inventor as a profit-sharing scheme.

It will be noted that the change of piece price is a part of the general scheme of piece pay; in practice it is perfectly available to any piece-work office, and has in itself no connection with the distinctive features of the premium plan, which are as follows: a combination of piece pay and time pay on each operation; fluctuation of wages cost, due to different day rates entering into, but not properly forming a part of, the cost of piece product; the maintenance of day rates among piece workers with their constant readjustment to ages and conditions; unequal pay for identical service by workers of different day rates; an initial investment of "liberal" day pay for less than a day's work, followed by reduced piece work in the hope of lowering the high wages cost resulting; that is, an attempt to recover the amount of the overpay by taking it from the worker's rewards on the piece pay part of his contract, and so reducing his incentive, effort, output, and the productiveness of the shop; the employment of workers with the understanding that there will be no demand for any increase of product per unit of wages beyond the actual day work record at that date for that group of elementary operations, however old and poor the record may be known to be, or however easily the product of an automatic tool may be determined in advance.

More than this would be piece pay, from which it is claimed the premium plan differs radically in avoiding the elements of demand and wage penalty.

We can best compare piece work and the premium plan by assuming them applied to actual manufacturing operations, of which we will consider two opposite classes.

1st.—Fully or partly—automatic machines whose rate of production (when running) is easily determined and almost or quite independent of the worker.

2nd.—Work that depends largely on the skill and effort of the worker, whose speed on new operations increases rapidly.

These are represented in my experience by the punch-press department and coil-winding department of an electrical-manufacturing works under my supervision. For several years these two departments have run for the most part on piece work.

In the punch-press department we will consider an automatic tothing press making two hundred strokes per minute, the blanks being fed in and product removed without stopping the machine. Here piece work assures the following:

So long as work can be found to do, the machine runs continuously at full output without unavoidable delay from loose belts or in waiting for tools, raw materials, helpers, or orders. Delay is reported immediately and the cause removed, for the operator's pay depends on the product and his efforts are directed towards the removal of all obstacles to large production.

The operator learns to look forward, anticipate, and avoid delays, and he keeps all related departments up to their work. While this may call for no physical effort it may demand much attention and energy. If the supply of work fails, the operator goes home at once without question or complaint, for he has not been taught to believe that his mere presence in the shop is worth a fixed time rate. If a high-priced day worker from another department be placed upon a press, he is usually called upon to choose between the temporarily reduced earnings and temporary dismissal, but, if necessary in special cases, he may be paid the value of the piece work and an additional day pay amount, which will be charged, not to the product of the punch press, but to the general expense of the department for whose future need he is retained. This cannot be done until the necessary orders are issued with the proper authority.

The superintendent may rest assured that the equipment cost of product will not be increased by unavoidable delay, or the wages cost raised by high-priced day workers. The price is known immediately and positively. If the production be increased by improvement in construction or method of operating, the piece price will be reduced in proportion, and the worker will receive no benefit from the improvement unless as a reward for suggesting it, of which matter the management alone can judge and must be free handed to act.

Piece work answers all the requirements in this department, while the premium plan offers the most absurd and absolutely purposeless complication of day rates, factors, and variable wage-cost of product.

To begin with, it is not even consistent with the promises of the premium plan, to estimate the proper speed of the press and demand an equivalent of production per dollar wages. Aside from this, however, the system is defective, for the following reasons:

If the day worker were called upon to operate the press he would receive "liberal" day pay and a premium in addition, or, perhaps, several times what the work is worth. Even if the day rates and earnings differ by only a fraction of a cent per hour, dissatisfaction will arise. If the worker were dishonest, he could so charge his time spent on high-premium operations as to receive double pay for a part of it on some other job, which is a defect of any system combining time and piece pay, and ensues when the worker fails to deduct all of the piece-work time from his returns for day pay. Owing to the high day pay, the punch department would carry an operating expense of another department, and its product would be wrongly charged with it. The superintendent would not know whether the operators were running their machines, or drawing the "liberal" day pay of the premium plan. The placing of expensive operators on the work would be in the power of the foremen. Knowledge of the cost of product would be delayed and inaccurate. If the superintendent had any sense of justice he would endeavor to readjust day rates to get them equal without reducing any and without raising the average, which is, of course, impossible, and the effort results in a gradual creeping up of day rates.

I make the proposition that we count the number of strokes of this punch press and estimate its proper output; but Mr. Halsey tells us, regarding such rate setting, that he has "met very few mechanics who believe it can be done," and that piece prices must be made up from day work records. Mr. Taylor, however, has shown that it can be done, not only on the punch press, but on the planer and lathe and on nearly all general shop work, with sufficient accuracy to remove all need of rate cutting, not only in piece work, but even (as he proved) in the intensified differential piece-rate system. In this class of work the premium plan must fail, because it lacks penalty and introduces time pay. This represents the rapidly growing class of work, which already includes most of the operations of a modern general shop and is in the direction of modern progress as product becomes specialized and equipment automatic.

In the coil-winding department we have somewhat different conditions. Piece work is paid on all manufacturing work, but there is a proportion of repair work, which must be paid by the hour. There

are two classes of workers—the special workers and the “allround” experts. The special workers, who have very low and merely nominal day rates, do only piece work, while the “allround” men who alone do both day work and piece work, have much higher rates. Here, again, the conditions are what they should be—each paid his value at that work at which he is employed at the time.

In this department, on new work, the time required for an operation cannot always, as yet, be accurately foretold, and speed of production depends largely on the skill and effort of the worker and increases rapidly for some time. If piece pay be used, rate reduction in some form is necessary.

The writer was confronted some years ago with the problem of rate setting in this department. His first intention was to change the department to day work, each worker to receive a day-rate equal to his average earnings. This was met by a general protest from foremen and workers who claimed that day pay would take the interest and life out of the work. In this field, if any, the premium plan should succeed. What has it to offer?

1st.—It is impossible to pay the high day-rate men full pay for a small day's work, and a premium in addition. Mr. Halsey has not told us what to do in such cases. It appears to be a fatal defect in the premium plan.

2nd.—In paying even a little more per piece to one worker than to another, the premium plan would defeat the chief purpose of the piece pay in this department, and could not fail to cause friction and jealousy in place of rivalry and interest.

3rd.—The premium plan gives us a complication of entirely unnecessary day rates, factors, and limits among the piece workers.

4th.—As to rate reduction, the premium plan proposes a never-ending process of paying less per piece the faster the production on all work (which is rate cutting), as a substitute for periodical rate reduction, which is now necessary on only a few of the operations even in this department, and is rapidly dying out as the piece-work office accumulates data and gains experience.

Moreover, this reduced piece price does not even abolish the need of periodical rate cutting, but merely postpones it the longer the smaller the premium factor, and, by pretences and promises, makes it more difficult or impossible at a later date.

Finally, even if this reduced piece price were of value it could be utilized by our present piece-work office, without any change of system whatever, on those operations only where it is required.

We cannot expect an operator to put forth the same effort for the one-cent-per-piece premium as for the three-or-four-cents-per-piece incentive of piece work, and we cannot consent to cripple our piece-pay system on all work in a vain attempt to profit on a small and decreasing number of operations.

Piece work in this department is of great value in simplifying cost keeping and pay sheet, in valuing product, in ensuring full output, and in its effect on the workers. Rate reduction is avoided as far as possible by intelligent rate setting, but, where necessary, the piece price is reduced at definite and understood intervals, or is guaranteed for a given period of time or for a large order of pieces. I believe that this gives the best results with the least possible loss of incentive.

The premium plan would again fail to meet the requirements; in short, is useless for both classes of manufacture.

In answer to the above it may be objected that the premium plan has succeeded in practical application. In this connection it may be of interest to examine and compare the essential features and the records of actual performance of the Taylor differential piece-rate system and Mr. Halsey's premium plan.

It will be noted that Mr. Taylor and Mr. Halsey have each claimed the discovery of a system for general shop use that will remove all cause of contention between works and worker. Each has tested his plan by years of actual use in shops of unquestioned standing; each has exhibited his results in an apparently convincing manner. Yet these two systems are absolutely opposite and contradictory in every essential, and one or both must be wrong for general use.

Both are extremes, but on the opposite sides of piece pay as ordinarily applied, while Mr. Halsey's plan contains in addition the time-pay mixture.

Mr. Taylor's differential piece-rate plan is dependent on the most thorough methods of valuing labor operations by his elementary rate-setting processes. Mr. Halsey, however, has "met very few mechanics who believe it can be done," and he proposes (in his theory at least) to depend entirely on the actual time results obtained in the shop on each combination of elementary operations, "basing the piece prices on previous day's-work results, as must be done."

Mr. Taylor's plan goes to maximum speed at once by demand and reward. Mr. Halsey's, step by step with a premium. Mr. Taylor's plan is piece work intensified by a factor greater than unity, and places a severe wage penalty just behind the established high speed of production. Mr. Halsey softens piece work by a factor less than unity,

and claims that no penalty is necessary. Is not this due to the premium plan never reaching a really high production?

Mr. Taylor has specially guarded against defective workmanship. Mr. Halsey cannot consistently apply the ordinary safeguard of piece work.

Mr. Taylor's plan seeks high shop productiveness (low equipment cost), and assumes that the management is willing to pay the worker extra per piece for it. Mr. Halsey tells us that, under a fixed piece rate, "increase in production by a workman results in an immediate gain to the employee only," and he therefore pays less per piece the faster the production, or demands a share of the worker's profits.

These two exhibits of actual performance show how useless such records may be as evidence unless they are thoroughly investigated.

In the introduction to the records of results of the premium plan in the *American Machinist* of March 9th, we find the following: "Where the day's-work time has seemed to the superintendent to be excessive, the limit has been placed below the record." Are we to understand that such setting back of the time limit must be credited to a premium plan? The superintendent sets an arbitrary labor value on operations, below that for which they have been done, and demands increase of product for old day wages. It is well known that such procedure will often greatly reduce cost without any system whatever, and the necessity of it exhibits the weakness of the premium plan, with which it conflicts.

The author has given us, not a comparison of piece-pay systems, but a combination of the superintendent and the premium plan on one side, against a day-work condition so poor as to call for the violation of the very first principles of the premium plan. We must ask:

1st.—How much of the cost reduction was due to the general overhauling of day work, and how much to the premium plan?

2nd.—How much greater speed (and reduction of equipment cost) would have resulted from the three-and-four-fold incentive of piece work?

3rd.—Of what use are day rates in piece pay, if the superintendent sets back time limits to suit himself? Why bring in the complication of day pay at all, and why should the management tie its hands with promises to depend on day-pay record in rate setting? The setting back of the day-work time limits amounts to rate cutting, because of the pretensions of the premium plan.

In the premium plan, if the worker has culpably failed to get the work out of his machine, there can be no demand for improvement

or penalty for continued failure, but we must reward him by premium for doing (if he sees fit) what he should have done earlier.

In short, a distinctive feature of the premium plan is the essential absence of that wage penalty which is necessary to the practical working of piece pay. The worker may choose at any time, even during the progress of the work, between day pay or a small premium for extra effort. This is equivalent to "guaranteed day rates" in piece work, which we find by experience must be avoided at all cost, because it destroys the effectiveness of piece pay by annulling the element of penalty and the sense of responsibility.

Piece work depends on wage penalty for its discipline and selective effect in encouraging quick and accurate workers, while weeding out and quietly dismissing the less desirable. Only by wage penalty can the action of piece pay be cumulative and progressive, for without it a point is soon reached where progress is counteracted by the slipping back of productiveness and quality. Only by wage penalty can we hold the works to a high standard of output and quality, and render the operation automatic and "whip-cracking" unnecessary.

The first effect of incentive to effort may be spoiled work; it is absolutely necessary as a means of discipline that the worker be made to replace his labor on it, or, at least, that the employer be free to demand it. It is the management's right in the piece-work contract and its hands must not be bound by premium promises. It is the proper and only means of keeping out inferior workers, with whom the country is flooded; and it is necessary in justice to those workers who have properly mastered their trades. We can accomplish very little without the element of wage penalty, and any system is weak which rewards failure or refusal with full day pay.

Wage penalty for failure in amount or quality of product is not consistent with any system which recognizes an arbitrary time value of the workers and bases remuneration on it. In the premium plan, the withholding of the premium only is equitable and is insignificant in effect. The attempt to tack on a practical wage penalty to the premium plan is inviting a strike among workers, while the management's hands are tied by promises of reward without penalty, under which the men were employed. This, we are told, has occurred in one shop.

It has been claimed that because the premium plan is closely related to day work, and because of its promises of reward without penalty or demand, it can be more easily installed than piece work and with less opposition from the workers.

The writer would reply that the installation of piece work in a day work shop is not necessarily a tearing out and reorganizing process. Each worker may be offered his choice between piece work and day pay on some special class of work. Having chosen, before beginning the work, he must be held to it for gain or loss, and must not under any conditions be allowed to associate ideas of time and piece pay on the operation, and it is in this that the premium plan fails.

When a single worker accepts piece pay and adds to his earnings, others will follow and see the justice of piece work and its advantages to the workers. Such offers are quite as effective as the promises of the premium plan, which must be paid for in full with interest when the practical operation of the shop shows they cannot be lived up to; and when the workers recognize the similarity between giving less pay per piece of product, and the demand of more product per dollar wages, as exhibited in the "setting back" process described in the published records of the premium plan.

It is impossible to live up to the promises of the premium plan and maintain economy of manufacture, yet these promises may be insisted upon and even abused by the workers in matters of rate reduction, of which only the management can judge.

Piece work transactions contain the elements piece price, pieces produced; and time spent. The premium plan adds to these, on every operation, change factor and time rate. This necessarily adds to the clerical processes of collecting and extending the labor returns, and causes variations in the resulting piece and day records, costs, and selling prices. The arbitrary time rate of the worker is usually established while on other work and does not properly enter into the cost of piece product. These variations are, therefore, not the result of greater refinement and accuracy, but the contrary.

Piece work is essentially less complicated and more accurate than any combination of piece and time pay. Wise managers will avoid complications of non-productive processes, especially where they make costs inaccurate and inaccessible. Mixture of time and piece pay in the same transaction is such a complication, and is a characteristic of the premium plan.

It has been claimed that flexible piece price is a "commanding advantage" of the premium plan, yet it is more available to direct piece pay and, further, we note that in the leading exhibit of the workings of the premium plan a fixed 50 per cent. factor is used throughout the works.

It has been suggested that the reduced piece price is especially

justified on self-feeding machines, on which increased output can be obtained without considerable physical effort on the part of the worker. On the contrary, it is on this semi-automatic equipment that maximum output can be most easily and exactly determined and there is least danger of unexpected growth of earnings. It is on such expensive tools that we desire above all to obtain full output, and must have a severe penalty; in short, it is on such equipment that there is least excuse for diminished piece price and an enfeebled system of remuneration. It is on such work that Mr. Taylor's intensified plan has given the best results.

To sum up: The premium plan is combined time and piece pay with guaranteed day rates, extravagant day pay, a lack of penalty, and diminished piece-pay incentive bound together by indefinite promises. It is a reassembling under a new name, of those very elements which piece work is intended to avoid; the combination of those ideas which must be dissociated in the minds of the workers before piece pay can be effective. In my opinion, it is an attempt to get something for nothing by the complication of internal mechanism.

The problem of reducing rates in piece pay without discouragement to the worker must be met fairly and free handed, and no complex system involving time pay can possibly supply in advance engineering data as to the value of elementary operations.

Piece work is broad and flexible in every feature, and sets out to obtain all the advantages of piece pay by the direct application of every means available. It may use the change factors of both Mr. Taylor's and Mr. Halsey's plans, and may utilize Mr. Taylor's piece-rate-setting methods, or day-work observations of actual time, each as best suited to the work in hand.

The premium plan must enfeeble the entire piece-pay system by reduced piece price on all work, or pay more than the work is worth, and is bound down to the use of actual day-work records in establishing piece prices.

It is quite possible for a works, especially if already organized under piece work, to adopt a reduced piece-work system, in which all workers on one class of work are given equal day rates and are kept inflexibly in that department and on that work. The principles, promises, and pretences of the premium plan may be dispensed with, penalty enforced, and time limits set back below day-work records. This may go under the name of "premium plan," but bears no relation to Mr. Halsey's plan as described by him. It is merely a complicated and crippled piece-pay system.

Plain honest piece pay, with penalty for slow work and for work spoiled, is best for the works and for those workers who understand their business; it prevents good workers losing in favor of inferior mechanics, but superior bluffers, who are the only men that have "deep-rooted objections" to piece pay, and they become very scarce in a properly handled piece pay shop.

Shops that are well organized under a good piece-pay system, with full penalty, show much more snap and life and even better workmanship than those which have not received the selective action and discipline of a penalty system.

I confidently believe that properly handled piece-work shops are more secure against labor disputes and strikes, than those which employ on promises and pretences that penalty will not be enforced.

Workers are best employed for piece pay by telling them so plainly without promises and, above all, without elaborate systems with attractive names.

The variable piece price is available to piece pay, but it will not be generally adopted until more definite and quantitative reasons are given for abandoning the direct and effective fixed piece price with its much greater simplicity.

Piece work has, perhaps, in some cases been misapplied through ignorance of its principles, for piece-pay systems are edge tools that must be used intelligently. Mr. Halsey hopes to render them less dangerous by dulling the edge, but in doing so he destroys their usefulness.

The premium plan is the result of a disregard of equipment cost and the assumption that "an increase in production after the price is once cut results in an immediate gain to the employee only."

Of the many purposes and uses of piece work, the inventor of the premium plan has considered only its use in procuring increased physical effort of the worker, which may represent only a small part of its real value. In the premium plan he has forfeited many desirable features of piece pay and has produced an inconsistent and ineffective plan. He proposes to abandon exact and scientific rate setting and returns to the primitive methods of rate guessing.

Mr. Halsey states that the premium plan bears the same relation to piece work as "peace and harmony to discord and dissention," but I cannot find one feature of the premium plan in which it is better than direct piece pay, nor can I find any value returned to the employer to justify the poor investment of full day pay for less than a day's work.

THE WATER SUPPLY OF THE CITY OF GLASGOW.

By Benjamin Taylor.

THE water works of the city of Glasgow afford a striking instance of the extent to which the mechanical progress of the latter half of the century has affected engineering undertakings. If it were simply a pumping system, this would be so immediately apparent and so much to be expected that it would hardly merit comment. But Glasgow is supplied by gravity flow.

By the foresight of the past generation, for the benefit of the present, the water of one of the most beautiful of the highland lochs is discharged from the heart of the mountains into the heart of the city, at the rate of 50,000,000 gallons per day. This was the limit of the original design in bringing Loch Katrine to Glasgow when the work was planned some forty-five years ago.

The measure of a third of a century of mechanical advance is afforded by contrasting the old aqueduct with the newer one, and noting how improved methods and appliances for engineering construction on a large scale have not only cheapened and facilitated the execution of the work, but have made possible radical alterations in its design. The straightening in the line, shown on the accompanying plan, suggests the marked improvement over the original works by which the new works are characterised throughout. In the first place, the new aqueduct is $1\frac{3}{4}$ miles shorter than the old, and Mr. Gale has cut a more direct line, and moreover, he has reduced the amount of heavy masonry work to be built by skilfully avoiding the crossing of many deep ravines. There are 7 miles more tunneling in the new aqueduct than in the old, but tunneling is a much simpler operation now than it was forty years ago. By the use of compressed air for driving the drills for boring the shot holes, and by the use of more powerful explosives than gun-powder, the work of tunneling was much simpler on the second aqueduct than the first. Mr. Gale's design was so far different from the first works that the new aqueduct is practically a series of tunnels, and the aim throughout has been to keep the water channel as far as possible under and removed from the action of the atmosphere. The striking mechanical feature of the work is that of $23\frac{1}{2}$ miles of waterway, close upon 19 miles of which are in tunnel and about 3 miles in siphon. The length of each tunnel has,

of course, been determined largely by the configuration of the ground ; but wherever possible the length was restricted to one mile, so as to facilitate the removal of the spoil during construction. There are only five bridges on the new aqueduct, and the valleys of the Blane and the Endrick are crossed by siphons 3 miles 8 chains in length. To be more specific, the new aqueduct is $23\frac{1}{2}$ miles in length, of which 18 miles 78 chains are in tunnel, 1 mile 34 chains in cut and cover, and 3 miles 8 chains in siphons. It is larger than the old, being 12 feet wide by 9 feet high, and has a concrete invert throughout to ensure the passing of the maximum quantity of water.

At the time when the original works were built, two things were not foreseen. One was the resistance to be afforded to the stream by over thirty miles of piping ; the other was the enormous growth of the population to be supplied.

The population was then about 360,000, and it was calculated that, up to the end of the century, the increase would be at the average rate of 8,000 per annum. The drain to begin with was only 8,000,000 gallons per day. But the actual annual increase in the population has gone up, year by year, until it is now at the rate of 19,000 per annum, whilst the consumption of water per head has continuously increased, through the extension of factories, the provision of public baths, lavatories, and washhouses, the erection of baths in practically all but the very poorest of houses, until it is now 50,000,000 gallons per day. In forty years, then, the consumption has increased more than six-fold, and has reached the limit contemplated in the original design. But, as a matter of fact, the channels devised for the flow of 50,000,000 gallons per day were found in practice able to transmit only 42,000,000 gallons. It was not known, when the aqueduct was first constructed, how much the roughness of the inside of the pipes would influence the discharge. Darcy had not then instituted his famous experiments to determine the velocity of the flow of water in channels. It was not until 1880 that, by careful measurement, it was found that the maximum discharge of the aqueduct was 42,000,000 gallons per day, and that to pass even that quantity the sides of some of the trough bridges must be raised. But in 1852 it was estimated that in 1900 the consumption would not exceed 30,000,000 gallons. In 1855 the Parliamentary powers for the Loch Katrine scheme were obtained, and in 1859 the works were completed and the water was turned on by the Queen. By a long chain of aqueducts, tunnels, and siphons the stream was brought through hills and across valleys and rivers to Mugdock, on the side of the Kilpatrick Hills, some five or six miles



from Glasgow. There a reservoir was constructed, to store 400,000,000 gallons, and there strainers were erected, through which the stream pours before going into the service pipes for distribution through the city. The Mugdock reservoir, when constructed, was calculated to hold three weeks' supply. It now does not hold much more than a week's supply, for in 1898 the average daily consumption



AQUEDUCT NEAR COULEGARTON

was 52,630,000 gallons, and this year the average will be over 53,000,000 gallons, at the normal rate of increase. And here it may be remembered that the consumption is estimated by Mr. James M. Gale, the eminent water engineer of the city of Glasgow, at 55 gallons per day per head of the population, viz., 34 gallons per head for domestic purposes and 21 gallons per head for trade and public purposes.

The extensive works now approaching completion are intended to bring the daily supply up to 110,000,000 gallons, practically two and one-half times the amount which the original works have proved equal to, for although 42,000,000 gallons is the nominal supply of the old aqueduct, the actual flow does not exceed 40,000,000 gallons per day. Not all of the water supply of Glasgow is derived from Loch Katrine. Among the water companies bought up by the corporation was one called the Gorbals Gravitation Company, which took the water from a stream flowing out of the hills in the Barrhead district to the south of the city. These works are still kept up by the corporation for the service of a portion of the area on the south side of the River Clyde. They provide about 5,000,000 gallons



LOCH KATRINE, THE SOURCE OF THE SUPPLY.

The farther end from the water works, showing Ellen's Isle and Ben Venue.

per day.* The area of the Glasgow corporation, as water commissioners, is about fifteen miles from north to south and about eleven miles from east to west and includes a population of over a million.

Every tourist in Scotland of course knows Loch Katrine, which Sir Walter Scott immortalised in "The Lady of the Lake." It is a lake of surpassing beauty, and its waters are of remarkable purity. It is also in a practically uninhabited district, so that it has been comparatively easy to prevent the drainage of the few houses in its water shed from finding its way into the lake; no bathing is allowed, and the little pleasure steamers, plying for the tourist traffic, may not allow any refuse or impurity to pass. Moreover, it is in a region with a high average rainfall, and the hills around are so bare and precipitous that the streams which feed it carry with them very little vegetable or foreign matter. The drainage of Loch Katrine is about 23,200 acres, and of its reserve feeder, Loch Arklet, about 3,000 acres. The top water level at which 110,000,000 per day can be drawn off is 373 feet above the sea. The lake was tapped about five miles from the

* About 2,500,000 gallons per day are also drawn from the river Clyde for the use of public works.

Trossachs end, and from the outlet to the reservoir at Mugdock the old aqueduct is $25\frac{3}{4}$ miles in length. For several miles it had to be driven through hard rock of a hill that separates Loch Katrine from Loch Chon and then cut through a long, rocky slope, after which ravines and rivers had to be crossed by tubular bridges. On this aqueduct there are twelve miles of tunneling, ten miles of open mason-work and bridging, and four miles of tubular bridging of streams and valleys. This aqueduct has an arched roof, is 8 feet high by 8 feet wide, and has a fall towards Glasgow of 10 feet to the mile. At the outlet from Loch Katrine, the works consist of a stone basin, 55 feet by 40 feet, with three cast-iron sluices between which and the mouth of the tunnel is a wire-netting strainer to arrest fish and all floating material. At the lower end of the loch was constructed a masonry dam, with two sluices, two salmon ladders, and a waste weir. This dam controls over 6,000,000,000 gallons. The other end of the aqueduct is the reservoir at Mugdock, which was formed by embanking a natural valley, and is 62 acres in extent. The water is not drawn off from this reservoir through the embankment, but by a tunnel cut through the hillside. Before entering this tunnel for distribution through the city piping, the water draws off through sluices into a well 40 feet in diameter by 53 feet in depth, at the bottom of which



SLUICES AND SALMON LADDERS AT THE OUTLET OF LOCH KATRINE.

are regulating valves. From this well two sets of pipes lead away, each $3\frac{1}{2}$ feet in diameter, before entering which again the water is strained through copper-wire netting.

These gigantic and unique works were completed in the autumn of 1859; but not very many years passed before it was foreseen that their capacity would prove insufficient for the needs of the community, at the rate at which these are growing. Without going over all the history of the deliberations and developments, it will suffice to say that in 1882 the corporation decided to duplicate the supply, by building an entirely new aqueduct. The necessary powers were obtained, and work was begun in 1886, the intention being to proceed by stages and at a moderate pace which would involve no call on the ratepayers. To double the discharge from the lake to the city involved three things—the construction of an entirely new aqueduct for the whole district, the construction of an entirely new and larger reservoir to hold the additional quantity on the outskirts of the city, and an enlargement of the storage capacity of the lake itself. The enlargement of the supply basin is effected by raising the high-water level of Loch Katrine to enable it to retain more of the hill-drainage, and in the future, as need arises, it will be further enlarged by drawing off the waters of Loch Arklet. This is a small loch, lying between Loch Katrine and Loch Lomond, which at present discharges itself by a noisy stream into Loch Lomond at the famous Falls of Inversnaid. It is, however, now marked off as an assistant reservoir in reserve for Loch Katrine, into which loch it will be made to flow, when needed, in the perhaps not very distant future, at the rate of an additional 10,000,000 gallons per day. The original works, with city piping, cost £2,500,000. The extension works will cost £1,500,000.

The act of 1885 gives power to raise the level of the loch by five feet, and also to raise the level of Loch Vennacher, from which compensation water is provided to the riparian owners on the River Leith. The potential capacity of Loch Katrine will be 9,849,000,000 gallons, and that of Loch Arklet 2,059,000,000 gallons: but the joining of the two lakes by means of a tunnel is deferred until the city is in need of the additional supply.

In the meantime the original outlet from the lake is being used for both aqueducts, but the contract for the last section of the new works has recently been let—one, namely, for the construction of a new outlet and a second tunnel through the hill that separates Loch Katrine and Loch Chon. When that is finished, the new aqueduct will stretch direct from the lake to Craigmaddie reservoir, which lies to the east

of the old Mugdock reservoir. The two aqueducts run side by side for a considerable part of the distance, and are nowhere more than $1\frac{1}{2}$ miles apart; and at several points are connecting aqueducts, by means of which the stream in one may be diverted into the other should occasion arise. At several points, too, the two aqueducts cross each other.

The longest tunnel on the new aqueduct is that known as the Keltie tunnel—2 miles 5 furlongs long, and 250 feet below surface level. It was driven from both ends, and from two shafts about 60 feet deep. This tunnel took four and one-half years to complete, and when the



MUGDOCK RESERVOIR AND GAUGE BASIN.

two faces met there was only a couple of inches of difference of level. The drilling of this and the other tunnels was partly by hand and partly by power rock-drills. Gelignite was the explosive mostly used. The first tunnel to be completed is actually the last on the aqueduct, being at Mugdock. This tunnel was finished as long ago as 1890, and was at once brought into use by means of "stop planks," so as to permit of the old tunnel being repaired. The small proportion of "cut-and-cover" work in the new aqueduct has been in consequence of the rock coming so close to the surface that it is as easy to drive a tunnel as to open downwards. And this is why Mr. Gale cut

a shorter route for the new line. In some of the cut-and-cover lengths, the ground is so hard that no lining has been necessary, only an arched roof. In some cases, the side walls had to be lined; in other cases, complete lining has been necessary. The general section in these cases is an invert of 9 inches, side walls 18 inches and a batter of 1 in 12, with an arch of 18 inches thick, covered with a three-quarter-inch layer of cement on top. In rock cuttings, 12-inch walls sufficed, but when the water run of the aqueduct comes above the level of the ground the side walls are three feet thick.

Of the two siphons already mentioned, the one over the Endrick valley is 2 miles 34 chains long. There are four pipes, each 48 inches diameter, laid at an inclination of 1 in 1,000; the fall is gradual to 280 feet, though the rise on the other leg of the siphon is very steep. There are three connecting bridges, one over the Forth & Clyde Railway, one over the public road, and one over the River Endrick—all



DUCHRAY VALLEY, SHOWING THE LINE OF THE AQUEDUCT.



PIPING IN THE ENDRICK VALLEY.

similar in design, and with spans varying from 36 feet to 84 feet. The pipes are carried across these bridges in cast-iron saddles, laid on beams. A scour-pipe, 18 inches diameter, with ordinary sluice valves, is at the lowest part of the siphon, and discharges into the Endrick. The piping not only passes under several roads, but also crosses a siphon of the old aqueduct; the construction is similar in the Blane valley siphon, which is 1,194 yards long, but has a fall of only 120 feet. For the greater part of the length of the siphon the pipes are bedded into the ground, with a bank 2 feet 6 inches deep, but at some points they are supported on masonry piers, 2 feet to 6 feet high. The maximum grade is 1 in 5, and the most acute curve is of 288-feet radius. The water passes from the aqueduct into the siphon in a valve chamber 30 feet by 12 feet by 16 feet, with concrete walls, backed by puddle to resist the pressure. The centre of the pipe is 3 feet 6 inches below the invert of the aqueduct and the inlet end is fitted with an open-frame sluice valve. There is also a 9-inch pipe to the siphon to carry off any air that may come in with the water. At the other end of the siphon the pipes discharge into a basin 30 feet wide, to the south of which again is a stop plank and overflow chamber.

On the whole line of the new aqueduct there are ten bridges of varying spans up to 52 feet 6 inches—that of the one across the Duchray water. These bridges are for the most part of concrete faced with whinstone and Loch Arne granite. They are comely structures which in no way mar the beauty of the scenery.

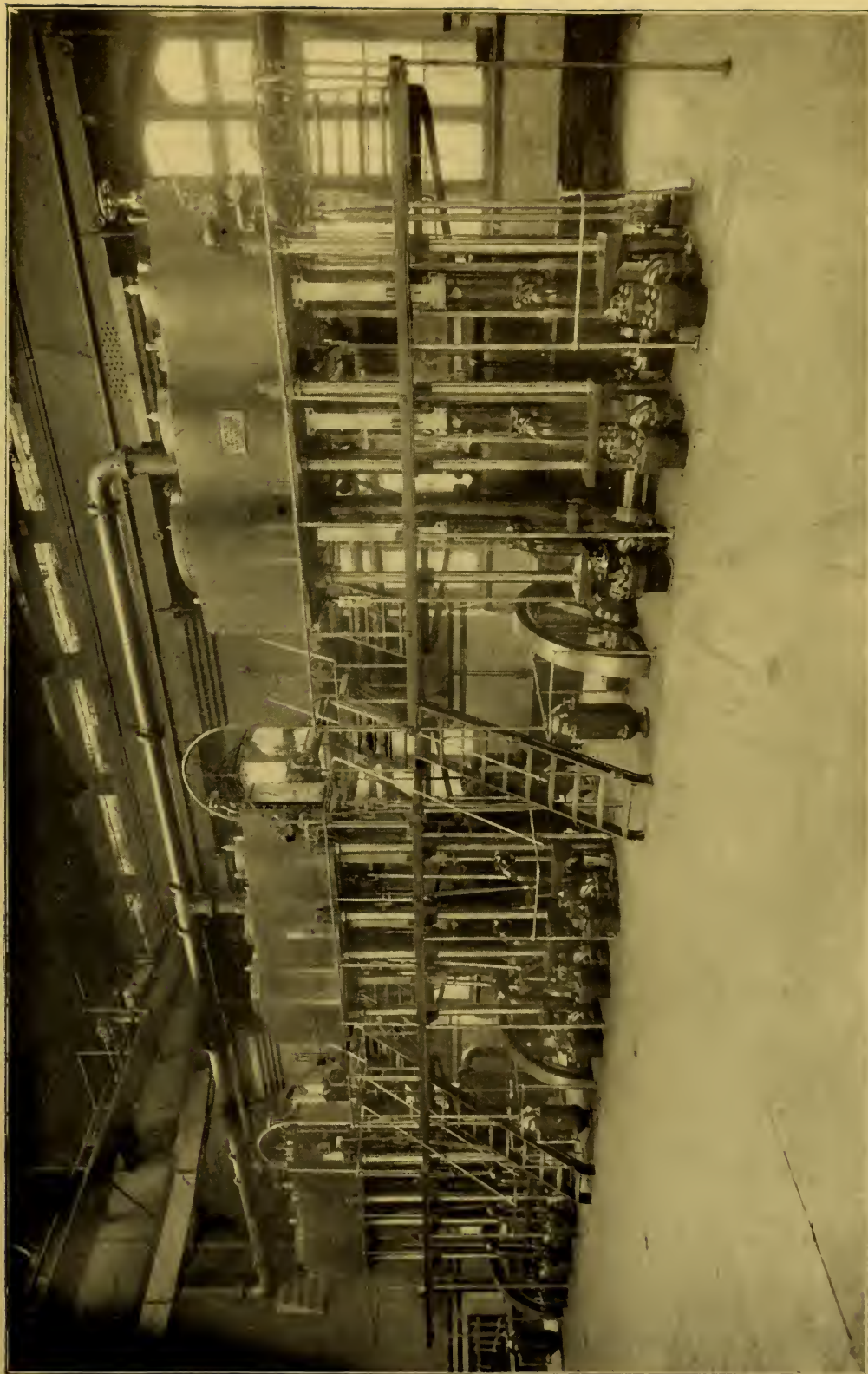
Undoubtedly the most difficult portion of the new works has been the Craigmaddie reservoir, the first contract for which was £105,000, but the ultimate cost of which was £300,000. Excavations had to be carried to a depth of 200 feet before a good bottom could be found for a puddle wall. Whinstone rock was found at no great depth, but so intrusive Mr. Gale would not take it as bottom but drove right through the whinstone to sandstone and shale beds beneath.

This new reservoir curves round three sides of a hill and is quite close to the old Mugdock reservoir, with which it can interchange supplies. It has a water area of 88 acres and a storing capacity of 717,000,000 gallons.

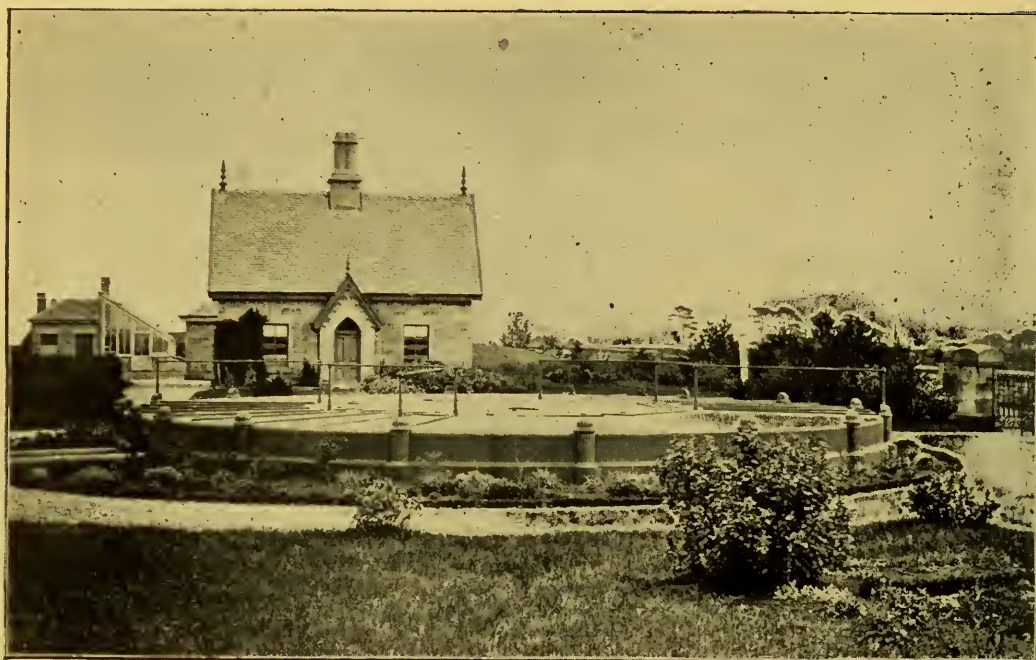
The inlet works of the new reservoir consist of an aqueduct capable of conveying 110,000,000 gallons per day from the south end of the Mugdock tunnel at which the waters of Loch Katrine emerge after their long journey through the hills. The two tunnels are connected at their outlets by a junction aqueduct and stop-plank chambers, so that the flow of either or both of the aqueducts may be directed to either or both of the reservoirs.

At Springburn, $8\frac{1}{2}$ miles from the reservoirs, is a pumping station and a high-level tank for the purpose of maintaining a high pressure on the elevated lands around the city. This high-level reservoir is 369 feet above sea level. It costs 21 shillings 6 pence per 100,000 gallons to bring Loch Katrine into Glasgow and 35 shillings 6 pence per 100,000 gallons to work Springburn pumping stations. The pumps throw 500 gallons per minute a height of 160 feet into the reservoir, which is capable of holding 750,000 gallons. Besides this, there is a station in the east end of the city for the supply of water under high pressure for hydraulic-power purposes, the hoists and hydraulic presses in the city being very numerous. There are three sets of pumping engines of 200 h. p. each, four Lancashire boilers with economizers, and two hydraulic accumulators.

Each engine can pump 230 gallons per minute with a steam pressure of 120 pounds against an accumulator pressure of 1,120 pounds per square inch. The engines work independently and each delivers into one of the 7-inch mains which are laid throughout the district of supply in two separate circuits. At certain connecting points are



HYDRAULIC-POWER PUMPING STATION, IN CONNECTION WITH GLASGOW WATER WORKS.
Three sets of pumping engines, 200 h. p. each. Steam pressure, 120 lbs. Accumulator pressure, 1,125 lbs.
Made by Messrs. Hugh Smith & Co., Glasgow



STRAINING WELL AT MUGDOCK RESERVOIR.

valves which admit of the system being worked as one circuit, and connected with the 7-inch mains are 5-inch and 6-inch pipes provided with valves by means of which any street can be cut off the general circuit. There is a tank capable of holding 200,000 gallons which is built of $\frac{3}{4}$ -inch and $\frac{5}{8}$ -inch iron plates and is divided into two portions. In the construction of this huge reservoir the plates were subjected to very searching tests. Each plate was supported on its flange ends and a weight of five tons applied to the centre; upon a bar not exceeding 6 inches wide on the face, the maximum deflection was not allowed to be more than one-eighth of an inch.

The following note on the bridges of the aqueduct is from a communication by Mr. Gale:

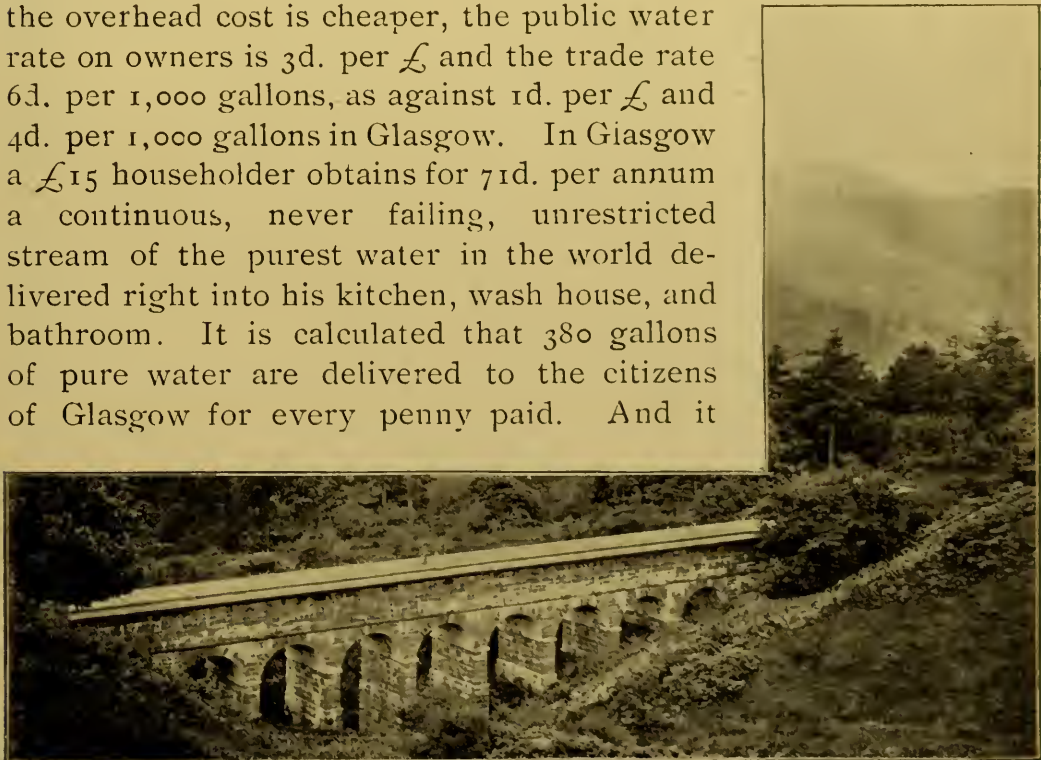
"It was at first intended that the new aqueduct should follow pretty closely the line of the old one and in designing the works the best kind of bridge for carrying the water-channel across ravines on the line, especially those in the vicinity of Coulegarton and the Duchray water had again to be considered. There are five of these bridges, varying in length from 372 feet to 996 feet, and of a total length of 2,907 feet.

* * * "The masonry bridges on the line of the old aqueduct have given much trouble. On the occurrence of severe frost, the top courses of the masonry are lifted from their beds, causing extensive leakages which have to be made good by cementing inside. This, however, has been permanently cured as regards five of the bridges north

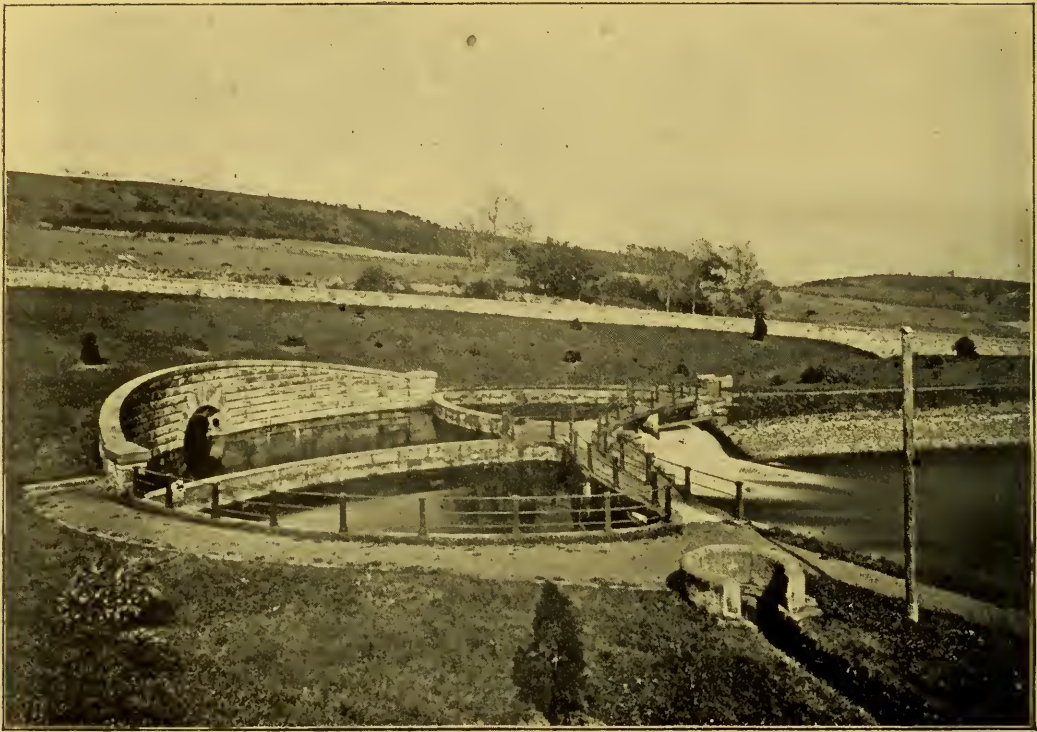
of the Endrick valley by lining them inside with cast-iron plates. It was therefore resolved 'hat, instead of following the old line, the new aqueduct should consist throughout of a series of tunnels and that the water channel be kept as far as possible underground and removed from the action of the atmosphere."

The last tunnel—that through the ridge which separates Loch Chon from Loch Katrine, 1 mile 3 furlongs long—was driven through in June, 1898, and is being rapidly completed along with an inlet similar to that of the old aqueduct. There remains, then, of the whole great design the new outlet works at the lower end of Loch Katrine, which include a new masonry dam by means of which the water level of the loch will be raised 5 feet, bringing its storage capacity up to 9,849,000,000 gallons. The contract for this last section of the work will be completed in the course of the present year.

According to figures compiled by the city chamberlain, Dublin has the cheapest water in the United Kingdom, the cost working out at 0.857 of a penny per gallon per annum. Glasgow comes next however, at 0.963d. Then comes Dundee, 1.077d., Edinburgh, 1.340d., Newcastle 1.860d., Leeds 1.875d., Birmingham 2.453d., Manchester 2.476d., Bradford 2.770d., Liverpool 3.062d. But in Dublin, though the overhead cost is cheaper, the public water rate on owners is 3d. per £ and the trade rate 6d. per 1,000 gallons, as against 1d. per £ and 4d. per 1,000 gallons in Glasgow. In Glasgow a £15 householder obtains for 71d. per annum a continuous, never failing, unrestricted stream of the purest water in the world delivered right into his kitchen, wash house, and bathroom. It is calculated that 380 gallons of pure water are delivered to the citizens of Glasgow for every penny paid. And it



AQUEDUCT BRIDGE, DUNTREATH.



THE END OF THE AQUEDUCT, MUGDOCK RESERVOIR.

Showing mouth of tunnel and gauge basin.

is water of such peculiar softness that the householders of Glasgow can pay their water rate out of what they save on soap.

Loch Katrine water is not only soft, it is remarkably bright, clear, and free from vegetable matter, because of the bare and precipitous character of the hills which drain into the loch. It is uniform in colour, temperature, and quality, is absolutely free from pollution and must remain so because the corporation have now bought up the building rights of the whole drainage area; it needs no filtration and is practically unaffected by the change of seasons. Sir Walter Scott has sung the magic beauty of this lake, but its greatest beauty is after all the beauty of utility, the sustaining influence of its waters supplied to a million thirsty beings, and to thousands of insatiable factories thirty-five miles away.

ELECTRICITY IN THE MINES AT CRIPPLE CREEK.

By Thomas Tonge.



CRIPPLE CREEK is perhaps the only gold-mining district in the world where a miner can go to his work in an electric street-car, descend the mine in an electric hoist, keep his mine dry by an electric pump, do his work by an electric light, run drills operated by electric air-compressors

(possibly, in time, to be superseded by direct electric drills), and fire his shots by electricity from a switchboard remote from the point of explosion.

The Cripple Creek district is contained within an area of a little more than six square miles, consisting of rolling hills and small valleys and gulches, at an average elevation of over 9,500 feet, with towns and villages at short intervals, such as Cripple Creek (altitude 9,510 feet), Anaconda (9,450 feet), Victor (9,500 feet), Altman (10,625 feet—the highest incorporated town in the United States), Independence (10,300 feet), etc. Among the intervening elevations are Globe Hill (10,740 feet), Bull Hill (10,780 feet), Battle Mountain (10,640 feet), Beacon Hill (9,720 feet), Raven Hill (10,350 feet), Gold Hill (10,300 feet), etc.

In this limited area there are upwards of one hundred and fifty shipping gold mines, fifteen of which produce over 1,000 tons of ore each per month. The gold production of Cripple Creek, in round numbers, by years, has been as follows:

1891.....	\$200,000	1895.....	\$8,100,000
1892.....	600,000	1896.....	10,000,000
1893.....	2,300,000	1897.....	12,000,000
1894.....	4,000,000	1898.....	14,000,000

Computations, made by reliable persons at the end of July of the present year, of the amounts paid out in dividends to the shareholders of Cripple Creek mining companies showed that the total had reached over \$8,000,000. The total for the present year, at that time, was already over \$1,250,000, with probability that the record of nearly

\$2,600,000 during 1898 will be exceeded this year. These figures relate only to the dividends actually paid by companies, and do not include the profits of mines owned and operated by private individuals, or the profits made by lessees, which, if they could be accurately ascertained, would very much augment the above amounts.

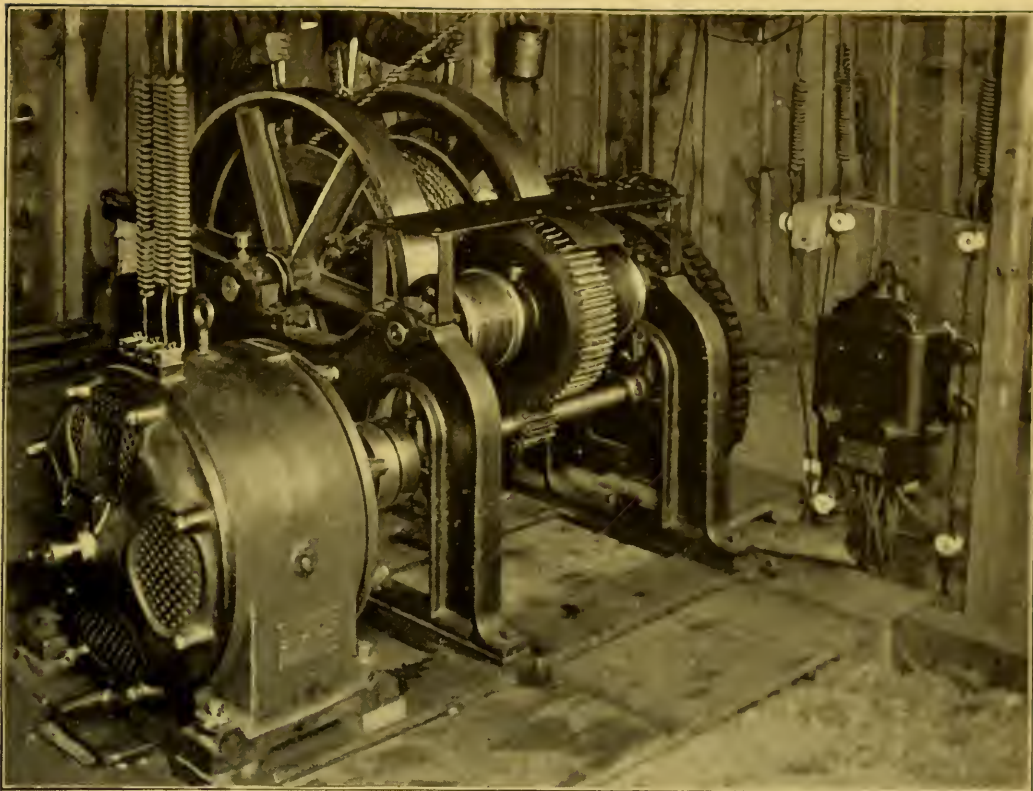
The whole Cripple Creek district, which in 1891 was a remote mountain pasture with less than a dozen inhabitants, has now a population of nearly 50,000.

During 1894 a narrow-gauge line, known as the Florence & Cripple Creek Railroad, forty miles long, was built at a cost of \$500,000 of Colorado capital, from Florence on the Denver & Rio Grande Railroad, tapping Cripple Creek from the south; since that time it has been extended so as almost to encircle the limited ore-producing district.

In 1894 also, a standard-gauge line, thirty miles long, known as the Midland Terminal Railroad, was built at a cost of \$25,000 per mile, from Divide, on the line of the Colorado Midland Railroad, tapping Cripple Creek from the north, the last fourteen miles being a circuitous route almost circumnavigating the mining district.

On account of engineering difficulties, these competing steam railroads (running frequent suburban trains) only *encircle* the cluster of gold-bearing hills, leaving a comparatively extensive centre in which steep wagon roads gave the only access to numerous rich mines, employing large numbers of men. The miners employed in such mines, therefore, had either to live in small and unsuitable cabins near their work or, if living in the towns, had the choice of taking a very laborious and exhausting climb to reach their work, or of keeping a saddle horse; many of them chose the latter alternative. Exclusive of the miners, there is very considerable travel by other people to and from the mines.

This condition of affairs led to the organization of the Cripple Creek District Railway Company and the building of an electric street-car line, which, commencing at the north end of the town of Cripple Creek (altitude 9,510 feet), traverses in a meandering course, on account of engineering difficulties, the entire centre of the district to Victor (altitude 9,500 feet) at the south end. The line is a little more than six miles long, and presents a constant succession of grades and curves; at a point known as Midway (10,514 feet above sea level and consequently 1,000 feet higher than its termini at Cripple Creek and Victor), it affords a magnificent panorama of the adjacent hills dotted with mines and waste dumps. The round trip, including



A 10 H.-P. ELECTRIC MINE HOIST.



THE GOLDFIELD ELECTRIC-POWER PLANT, PARTLY COMPLETED.
The mines on the hill are the Golden Cycle and the Theresa.

numerous stops, occupies about an hour. It is made at an average speed of about twelve miles an hour, which it is expected will be increased. The electricity is generated by water power at Lake Moraine (altitude 11,300 feet) on Pike's Peak and transmitted by wire nine miles to a distributing station midway on the line of the electric railway.

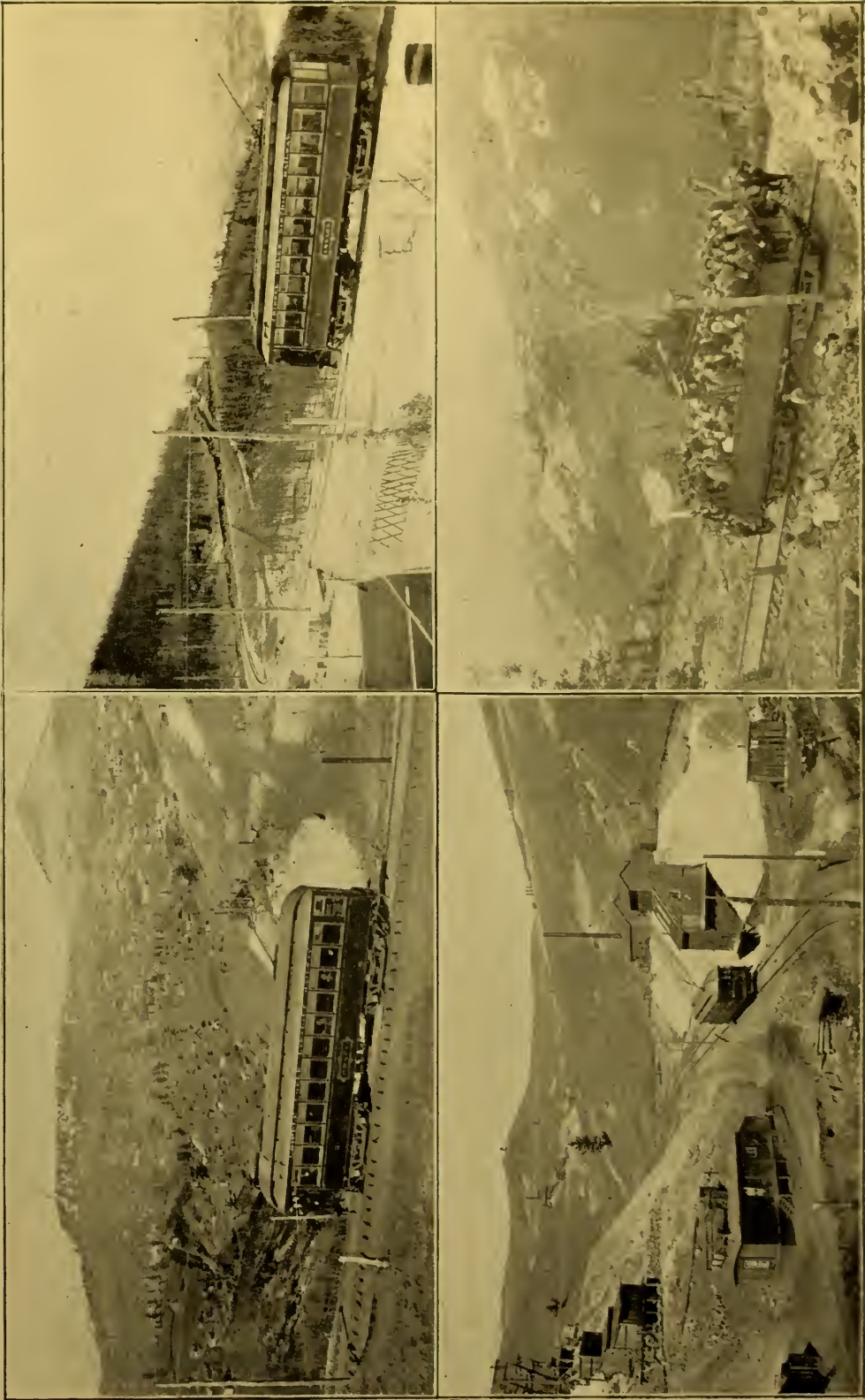
This enterprise recently passed into the hands of a syndicate of capitalists at Colorado Springs, Colo., large owners of some of the most profitable Cripple Creek mines, and it is their intention to make many improvements and extensions, including an extension of the line from Cripple Creek to Colorado Springs, a distance of 32 miles.

It is obvious that the sinking and operating of the mines of Cripple Creek have involved the expenditure of a large amount of power, which for the first seven years of the mining history of the district was derived exclusively from steam and therefore demanded vast supplies of fuel and water. As the mines are usually high up on the steep hill sides or summits the transportation of such fuel and water means very heavy cost.

Within thirty miles to the southward of the Cripple Creek district is the Cañon City coal field, 5,000 feet lower in altitude. The use of steam power, therefore, necessitated hauling the coal by railroad up grade to one or other of the various stations in the Cripple Creek district and thence by wagon up steep roads to the mines.

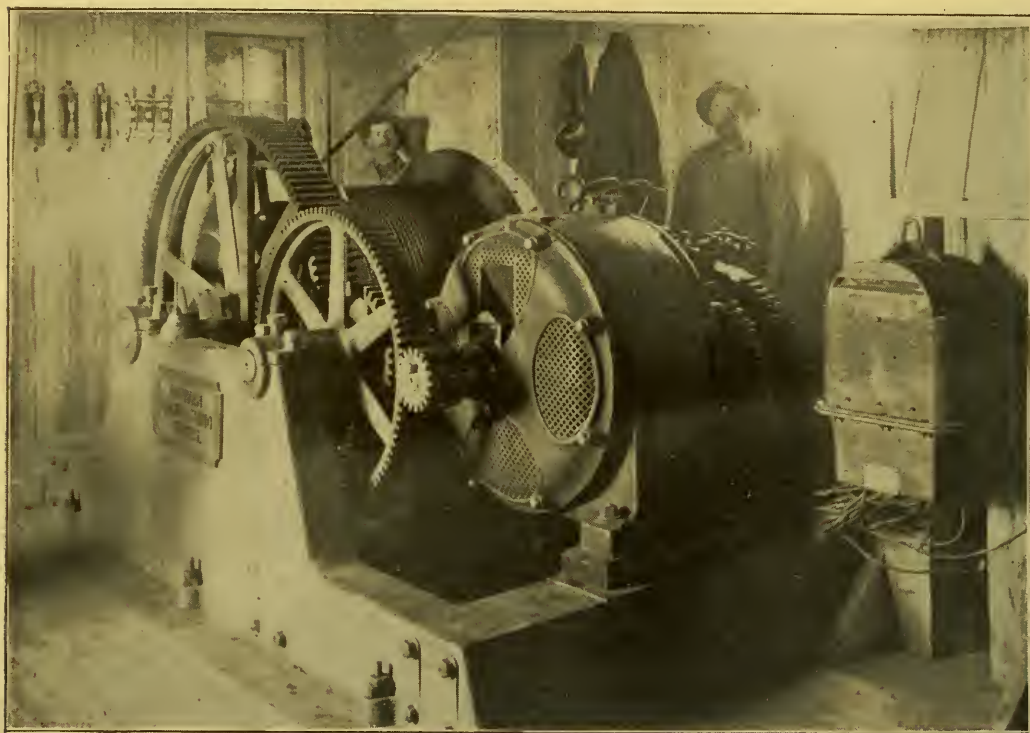
Cripple Creek mines have usually been "dry," and even in the exceptional cases where water has been struck at considerable depth the supply has been unreliable, as the driving of numerous long tunnels at great depth has had the effect of draining the comparatively few mines that had water. Moreover, there are no local streams of volume. Speaking generally, therefore, the steam hoists, etc., of the Cripple Creek mines have been depended upon water hauled by wagon up steep roads to the mines, from springs, etc., in the valleys. The high altitude—averaging 10,000 feet—increased greatly the risk of freezing and consequent stoppage in winter. Moreover, in many cases, the water has cost fully as much as the fuel.

Again, the class of steam mining machinery in general use is somewhat notorious for its consumption of steam, for which reason from one to five boiler horse power are required for every horse power produced by the machinery. The water consumption, as well as the coal consumption, for the power produced, is therefore very high in comparison with the same figures for more modern types of machinery.



VIEWS ON THE LINE OF THE CRIPPLE CREEK DISTRICT ELECTRIC RAILWAY.

The leasing system is very common in Cripple Creek. Prospectors of limited means and lessees for comparatively short terms, with ultimate success uncertain, were not in a position to purchase and put in steam plants with subsequent heavy expense of water and fuel.



30 H.-P. MOTOR AND HOIST, MATOA MINE.

The space occupied is less than one tenth of that required for the corresponding steam plant, including water tanks, coal bins, etc.

In July, 1888, the first electric hoist for mining purposes was started up in connection with the Western Tunnel, Aspen, Colo., and is still in operation. It was afterwards connected also with an adjacent shaft for hoisting purposes, the power for this and for additional motors subsequently installed being supplied from Hunter Creek, where a generator of 60 h. p. was first placed, and later another of 125 h. p. Early in 1893 another plant of nearly 500 h. p. was established on Maroon Creek, Aspen. To-day there are at Aspen electric motors, operated by water power, aggregating over 700 h. p. They are utilized for almost every mining and ore-treatment purpose and have replaced the steam engine. The success achieved at Aspen led to the establishment of larger electric-power plants in connection with various other mines in Colorado, notably at the Virginus mine, Ouray County, the Silver Lake mine, near Silverton, etc.

The above-described conditions at Cripple Creek, therefore, naturally resulted in the establishment of two electric-power plants, viz., that of the Colorado Electric Power Company at Cañon City, nearly 30 miles south of Cripple Creek, and that of the La Bella Mill, Water, & Power Company at Goldfield in the Cripple Creek district itself. In each case, the electric power is produced from steam generated by the same quality of coal, from the same Cañon City coal field; the special difference between the two plants being that the Colorado Electric Power Company generates the power at the coalfield and transmits it 27 miles by wire to the gold mines, while the La Bella Mill, Water, & Power Co. (practically composed of the owners of the Florence & Cripple Creek Railroad) carries the coal to, and generates the electric power in, the gold-mining district itself, thus constituting a competi-

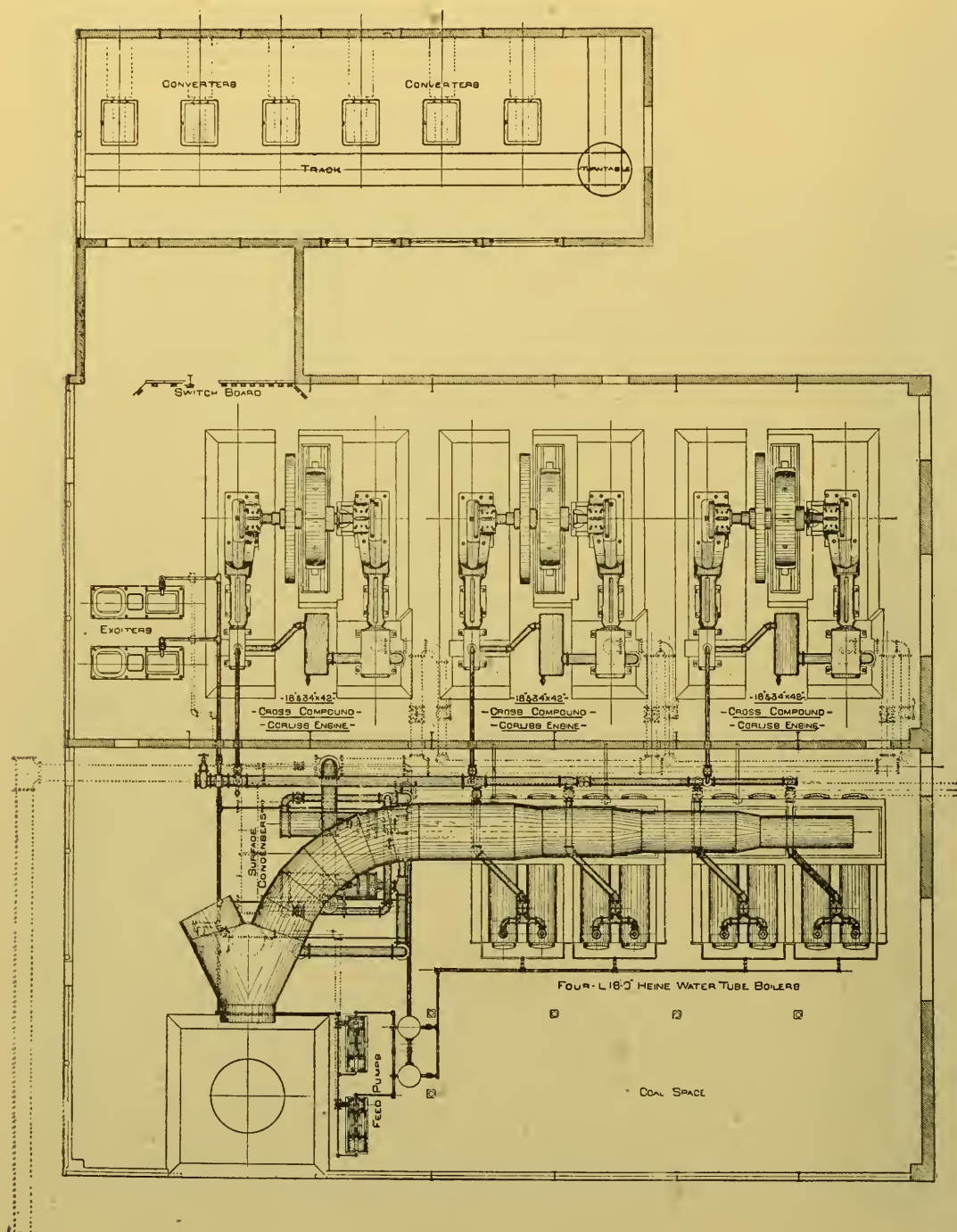


TWO VIEWS ON THE TRANSMISSION LINE FROM CAÑON CITY TO CRIPPLE CREEK.

The trail is cleared 30 ft. wide, to prevent trees falling on the line.

tion between modern electrical transmission and the older system of fuel transportation.

The Colorado Electric Power Co. (representing \$500,000 of capital, mostly from Pittsburg, Pa.) completed its plant at Cañon City in

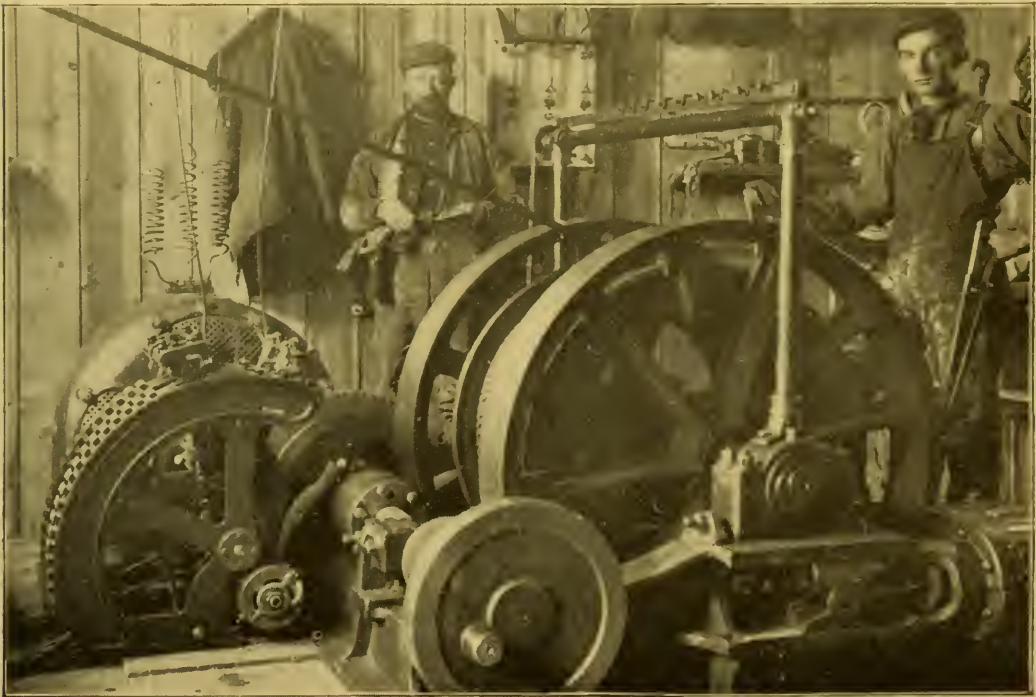


PLAN OF POWER HOUSE, COLORADO ELECTRIC POWER CO., CAÑON CITY.

August, 1898. It has a capacity of 2,250 h. p. The method pursued is to generate power at 500 volts, transform to 20,000 volts, and transmit at this voltage 27 miles to Cripple Creek. The transmission line consists of three No. 3 bare copper wires arranged in a triangle on 30-foot poles, one wire being at the top of the pole. The two wires of a

telephone circuit are also carried lower down on the same poles. At Cripple Creek there are two distributing stations, one on Gold Hill and the other on Battle Mountain, at which the current is transformed from 20,000 to 500 volts and distribution is made at the latter voltage.

The Colorado Electric Power Co. has already seventy consumers in the Cripple Creek district, representing an aggregate of about 1,200 h. p., the list comprising both mines and ore-treatment plants, by whom the power is utilized for hoisting, pumping, operating air compressors for drills, lighting, and, in the case of the ore-treatment plants, operating crushing and other machinery. Thus the Colorado



MOTOR RUNNING A HOIST FORMERLY OPERATED BY STEAM.

The plant is that of the Lafayette mine. The disconnected steam cylinder is seen on the right.

Ore Reduction Co. takes 150 h. p. for crushing machinery, etc.; the Lillie Gold Mining Co., 100 h. p. for hoist and air compressor; the Moon-Anchor Gold-Mining Co., 100 h. p. for pumping from a depth of 600 feet; the Taylor & Brunton Mill, 75 h. p. for crushing machinery, etc. The needs of the majority of the consumers range from 75 h. p. down to 5 h. p. A hoisting plant of 15 h. p. will suffice for a shaft 450 feet deep; when this depth is exceeded it is usual to put on 30 h. p., sufficient for 800 feet; for still greater depth 75 h. p. and 100 h. p. are installed.

The company rents to a lessee or prospector a small hoist, say

from 5 h. p. to 30 h. p., thereby enabling such lessee or prospector to put practically the whole of his capital into development work, avoiding the necessity of purchasing a plant. If, however, he finds ore in paying quantities and desires to purchase the electric-power plant he has rented, the company in the first instance gives him an option on it, the rent applying on the purchase price.

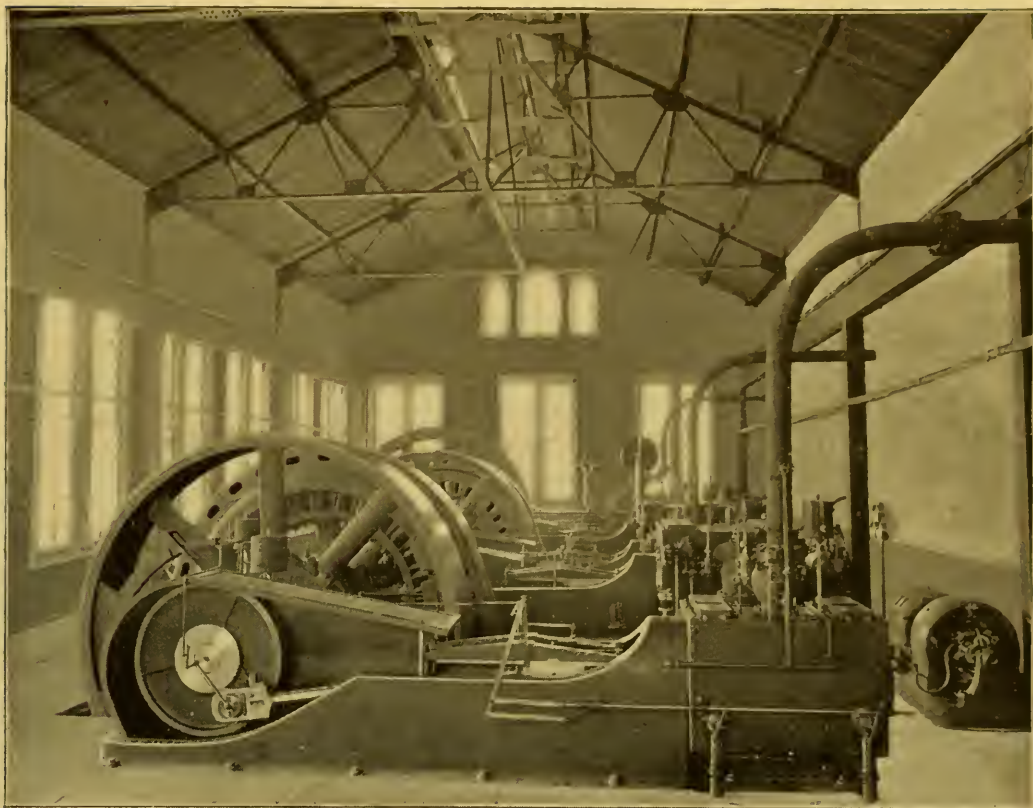
The minimum rent for a 5 h. p. plant is \$50 per month, including rent and power supply; from that sum the charge ranges upwards according to the amount of power used. Plants from 15 h. p. to 30 h. p. range from \$65 to \$200 per month for rent of motor, etc., and power supply, depending on tonnage and depth of shaft.

The company has \$60,000 worth of machinery so rented out and is preparing to extend its plant generally.

The following information as to the recently completed plant of the La Bella Mill, Water, & Power Co. at Goldfield has been furnished by Mr. L. L. Summers, of Chicago, who designed and superintended its construction and is now the consulting engineer. It has a capacity of 3,000 h. p., viz., 2,250 in electric power and 750 in com-



THE GOLDFIELD PLANT AND THE COOLING TOWER.



ENGINES, DYNAMO AND COMPRESSOR PLANT. LA BELLA MILL, WATER, AND POWER CO.

pressed air. It is one of the largest compressed-air distributing plants in the country, having ten miles of underground lines by which the air is distributed from the station to the various mines in the locality, including the Victor, Golden Cycle, Gold Knob, Granite, Rigi, Independence (of the Independence T. & M. Co.), Vindicator, Longfellow, Last Dollar, Union, Christmas, Jefferson, Ocean View, Anaconda, Ophelia Tunnel, etc. Some of these are as far as two miles from the station, while electrical power is transmitted five miles.

The loss in transmission of compressed air has received a great deal of attention by the engineers of the company and convenient tables have been prepared showing the loss by friction and by leakage.

As before mentioned, the capitalists composing this company are also practically the owners of the Florence & Cripple Creek Railway, and by this alliance the energy is distributed from the coalfield (by low fuel-freight rates) to the local power plant and thence to the mines, at a minimum rate.

The plant is modern in design and equipment, the machinery being obtained from the works of the leading representative firms of the United States. The specifications are said to have been most exact-

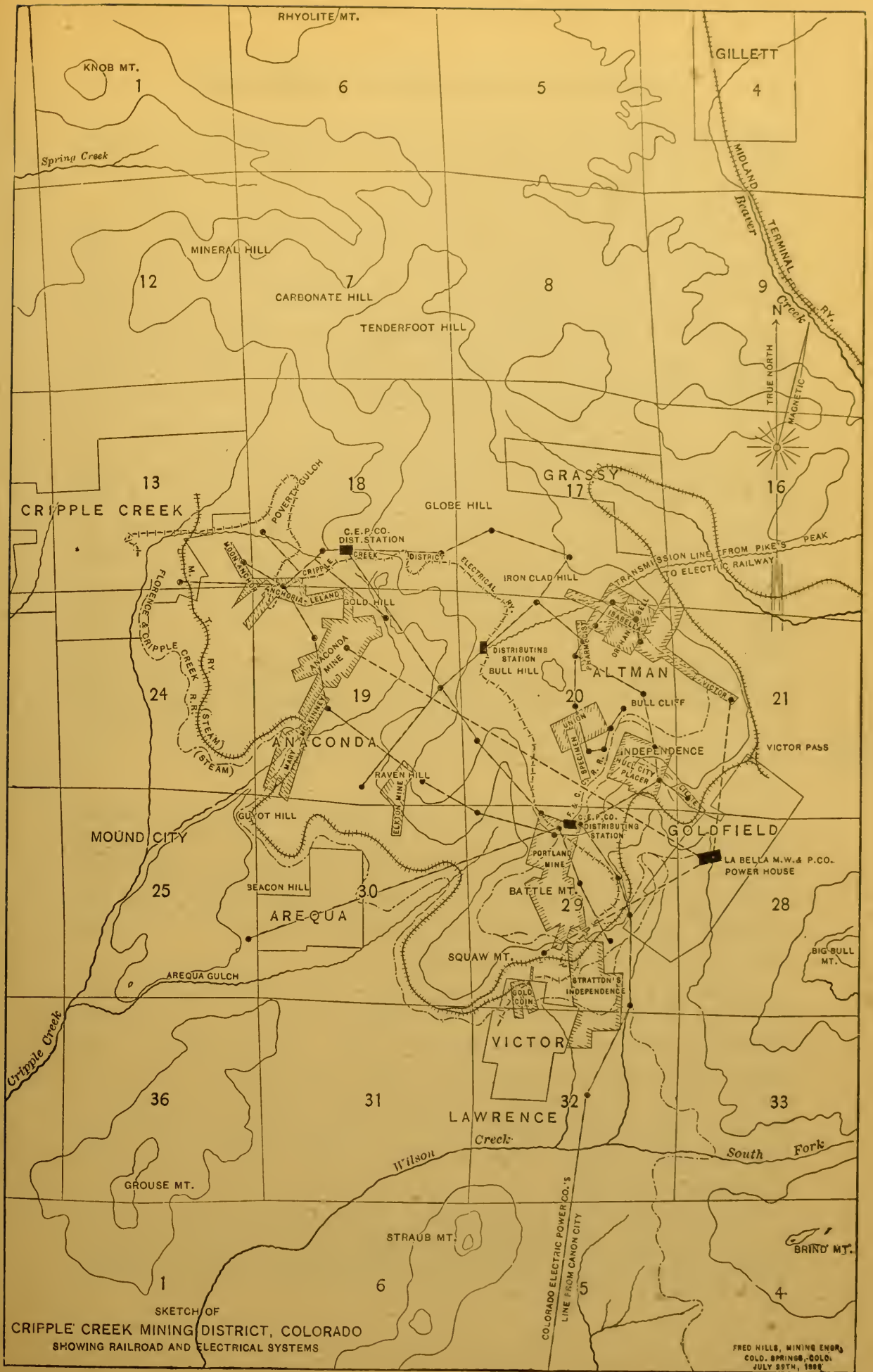
ing with respect to efficiency and economy. Automatic machinery is used throughout, the coal being dumped directly from the cars into overhead bins, whence it is fed by gravity to automatic stokers, the ash being handled by conveyers and placed on board the railroad cars to be used for filling purposes. This automatic handling of the coal and ash reduces to a minimum the number of employees and materially keeps down the wage account. The boilers are of the water-tube type, 150 pounds of steam being carried, while the engines are of the compound condensing type with the most modern auxiliaries.

An interesting feature of this plant is the fact that condensing engines are used at a point 10,000 feet above sea level, where water is comparatively scarce in the absence of natural water courses, and the limited supply from springs more or less unreliable. In order that



BOILER ROOM OF THE GOLDFIELD ELECTRIC-POWER PLANT, SHOWING AUTOMATIC FEEDING AND STOKING APPARATUS.

condensing engines may be used under these circumstances, provision has been made to cool the water by means of cooling towers, when it is again used in the condenser. This is the first application of the cooling tower in Colorado, and the results in so large a plant are being watched with considerable interest. The elevation of 10,000 feet ne-



cessitated considerable change in the design and details of the condenser, owing to the fact that the barometer pressure at that elevation is only about twenty inches of mercury.

The electrical power is distributed by means of the triphase system. The voltage carried on the distributing lines is 6,600. The pressure being carried directly on the generator avoids the necessity for the use of step-up transformers. A transformer is placed at each mine and the voltage of 6,600 is reduced to 110 volts or 440 volts, depending upon whether lights or motors are being operated. By means of the pressure of 6,600 volts any portion of the district can be reached with comparatively small loss.

The company distributes considerable power in large units, one hoist motor operated from their lines being rated at 300 h. p., while 200-h. p. and 100-h. p. motors will be comparatively common, as well as smaller sizes. The loss between the power house and this 300-h. p. motor, a mile distant, is less than 2 per cent. In this way, the pressure on the service is maintained with comparative steadiness, in spite of the fact that large motors are operated under fluctuating loads.

The advantages of modern high-tension distribution are illustrated in this plant in a most pronounced way as evidenced by the small loss of energy, and lights can be operated from the motor circuits without disagreeable flickering or any indications of fluctuating loads on the circuit.

A great part of the lighting of the Cripple Creek district (including Goldfield, Independence, part of Anaconda, part of the town of Cripple Creek, in competition with older lighting plant, and Victor in the near future) is done from this plant. In the case of city and residence lighting the circuits are normally operated from the generator not carrying fluctuating loads.

Speaking generally, the principal uses of the electrical power furnished by the above-mentioned two plants are hoisting and air compressing for the operation of machine drills. Air compressing in the larger mines consumes about four times the amount of power required in any other service, for the reason that the compressor is operated almost continuously, while the hoist, though consuming a large amount of power when in use, is in active operation less than one-fourth of the time.

It is estimated that in the Cripple Creek district the use as above of electric power, as compared with steam power, effects a saving of from 15 to 50 per cent., according to the location and circumstances

of the mine, irrespective of reduced wage account, and also irrespective of its greater reliability and convenience, as unaffected by frost.

Drills of German manufacture, operated directly by electricity, without the invention of an air compressor, have for some time past been in successful operation in the Silver Lake mine, near Silverton, Colo., and it is evidently only a question of a short time when similar drills will be in use in the Cripple Creek district.

Electrical power is revolutionizing the mining industry at Cripple Creek in reducing expenses, increasing profits, and making available lower-grade ore, hitherto discarded or ignored as incapable of being mined and treated at a profit.

The whole movement is one of those, most characteristic of modern engineering work, in which an advance in any department extends its influence to, and re-energizes, other branches. The effect of the introduction of electric power is not only to cheapen production in mines already profitable, but to bring into working deposits which could not be mined to advantage under the older methods. The net result is a great increase of activity and labor-employment, and new openings for the utilization of capital, not only in the mining field, but in the manufacture of the electrical and mechanical appliances which have so greatly facilitated mining work.

AMERICAN LOCOMOTIVES ON BRITISH RAILWAYS.

By Charles Rous-Marten.

IT was naturally to be expected that a subject so highly controversial as that with which I have been dealing would elicit strongly divergent views, not merely as to the conclusions deducible from existent facts but also as to some points in those facts themselves.

Therefore it caused me no surprise to receive communications from British and American engineers remonstrating with me upon my "advocacy" of certain methods, and upon my statements as to certain American practices, it being pointed out in the latter connection that these practices are by no means universal. It was in vain that I said in the penultimate paragraph of my first article (*THE ENGINEERING MAGAZINE*, July, 1899: "I have endeavoured, as an entirely independent and impartial observer, to present a strictly fair view of the case. I have refrained from expressing any opinion as to the relative merits of the rival systems and their fruits. Nor do I pretend to assert that the general rules of practice to which I have referred have no exceptions. But I have treated the situation as it is found to exist in ordinary experience." But I ask permission to repeat those explicit assurances now in order that no excuse may remain for any misconception. I am endeavouring to outline in strictly general terms the salient differences in the views and methods that are to be found in Great Britain on the one hand and in the United States of America on the other. I say emphatically that in each case the practice which is the rule will usually be found to have its exceptions.

Before passing on I would like to correct one small misprint on Page 558 (July issue) viz., "brass upper tubes" should be, "brass *or* copper tubes."

Coming now to certain phases of my subject which are being keenly discussed in Great Britain, I may first refer to a letter from an eminent American engineer which is mainly a protest against what he terms "the curious idea prevailing in England that all American locomotives are built to a few standard designs and that the builders compel purchasers to accept these designs or go elsewhere." But after arguing that there are as many differences of design among American locomotives as among British—or, indeed, more—and that "American builders build locomotives to suit the purchasers"—which I

should have thought would "go without saying"—he adds: "The greatest facility which American builders possess arises in part from their stock of drawings and patterns which are available in new designs and for such parts of the engines as are not required to be made to special drawings. Thus one form of sand-box may be used on a multitude of engines, although a special form will be made to the purchaser's designs whenever required. The small railways, of course, which do not employ skilled mechanical engineers, leave much of the designing to the builders, and there is no reason why engines for the same class of work under similar conditions on two different railways should not be of practically identical design."

It will be seen at once that this entirely fits in with what I stated in general terms. Manifestly, there would be cases in which the chief mechanical engineer of an American railway would stipulate for engines to be constructed in detail, as well as generally, to his own design. But I am assured by representatives of American engineering firms that in the majority of cases the practice is virtually as I have described it. That is to say, instead of parts made by particular makers—A's x , B's y , and C's z —being compulsorily used as is often required by British specifications, many parts of each engine can either be supplied from materials in stock or be made from patterns, templates, etc., already in hand.

On the other hand, an English engineer writes to me: "It is not in the patterns or templates, but in the American practice of making spare finished parts for stock that the Americans have the advantage. If they can take these parts out of the shops they can begin erection at once. Hence the quick deliveries. I have seen it contradicted that this is the American practice and if the contradiction is true then the Yankees are no better off at all than English in the peculiar cases I have taken, and some other causes must be looked for." One of these he takes to be "the baneful restriction of output advocated by English trade unions" and another "the advantage of practice in putting together a few types of engines which the American is always accustomed to as against the infinite variety of type which the English erector has to put together, so that the latter expends half his time in consulting the drawings whereas the former gets so accustomed to these types that an old hand needs to look at the plans only now and then."

I make no apology for quoting these various comments because they tend to throw a good deal of "side light" on the question. It will be noticed by any acute observer, reading "between the lines,"

that practically it all comes round to the general principles which I endeavoured to set forth in my first article, viz., that in those cases in which the American builder has an advantage over the British builder—and, be it remembered, it is cases of this class with which I deal—that advantage is mainly due to the method of practice on which I have laid stress, namely, that it is not necessary for *every* part of the required engine to be absolutely created afresh, or at least to be produced *ab ovo*, there being, if not the entire skeleton, at least a good many bones at hand with which to begin the constructive or erective work.

In the present cases, for instance, the engines could be supplied in time to the Midland and Great Northern Railways only because each of those lines consented to accept the ordinary American type and merely stipulated for a certain specific power, viz., that this should be equivalent to that of their own standard engines, except that in a few details, *e. g.*, in the materials used for tubes and fire-box, the British practice should be followed.

But there is another matter which should not be lost sight of in reviewing the whole situation, which it materially affects. Four of the most eminent British firms of locomotive builders have constructed for the Midland Railway a number of good engines of the present standard class and therefore must possess all the needful patterns, templates, etc. Clearly then, excepting for their not keeping in stock—so far as I am aware—a supply of spare finished parts, they stood on equal terms with the American builders in tendering. The disadvantage under which they laboured was the plethora of orders. This necessarily put them “out of court” because it incapacitated them from fulfilling one of the essential conditions—that of time. Otherwise they could probably have executed the order with as much despatch as the Americans—or nearly so. But, practically, the order as it stood—that is to say, to deliver the engines within a given time—could not be undertaken at all. And I believe a question of price also arose, but this is not disclosed.

Thus, then, we arrive at a new position of large interest on both sides of the Atlantic. It was expressed very pointedly a few days ago by Mr. H. A. Ivatt, the able locomotive superintendent of the Great Northern Railway, during a conversation with reference to the orders given by English railways for American locomotives. “It means,” he said, “that henceforward American builders will be in the field as competitors with British builders for the supply of such engines as the British companies themselves cannot build.” Clearly that is so. It is

virtually proved that, in certain cases at any rate, American builders can supply locomotives much more quickly and somewhat more cheaply than British makers hitherto have done. If experience should further prove that the American-built locomotives are for all practical purposes as good as the British-built engines, the sequel seems inevitable. It is certainly to be expected that, in that case, the British railway companies will prefer the makers who supply an equally useful engine and do so more speedily and cheaply. Obviously, then, the present situation is one of absorbing interest for both American and British engine-builders.

One question which arises in this connection I must leave for other hands to deal with. It is as to how far the American builders may be facilitated and assisted in their present and future competition with British firms by their possession of superior appliances. The idea naturally suggests itself on noting that the various machines in the Baldwin shops are actuated by independent electric motors. At the first glance I should deem this an improvement upon the usual British practice and one tending to enhanced speed and facility of working. I prefer, however, to relinquish the discussion of that phase of the case to someone who can speak from closer personal knowledge in detail of the method. But whatever may be the true explanation, the definite fact remains that there does appear to be a distinct American superiority in respect of feasible rapidity and economy of construction.

A few days ago I visited Derby by invitation for the purpose of examining the engines constructed at the Baldwin works for the Midland company, of which a number had been placed on some short sidings outside the works and were in course of erection by the representative of Messrs. Burnham, Williams & Co. and his assistants. Much difficulty has been experienced in obtaining a sufficient supply of skilled labour, owing to the large demand for it at the present time; the Midland company is bound only to provide unskilled labour for the erection. Consequently the progress has been slow and so far only one of the engines has been tried in steam. Unfortunately, this pioneer was immediately disabled by a slight accidental collision and has had to go in for repairs. Therefore so far not a particle of information can be given as to results. I may say that I was very favourably impressed with the appearance of the engines which, except for the domed sand-box above the boiler, had little of the unfamiliarity of aspect to British eyes that would have been given by a "diamond" smoke-stack, huge head-light, and "cowcatcher." Even the

double-bogie tender is no longer a stranger to Great Britain, although in British practice it is not deemed necessary to place on eight wheels so comparatively small a tender as that attached to these engines. Upon making a more minute examination, I could not help noticing the rougher external condition of some of the castings as compared with those in the Derby-built engines, in the parts where extreme finish was not required for practical purposes. But I could not see that the engines suffered any loss of usefulness through the external roughness of such a part as, for instance, the valve-chest, which, moreover, was not exposed to view owing to its casing.

Mr. S. W. Johnson, the eminent mechanical engineer-in-chief of the Midland line, who courteously accompanied me on my inspection, appeared to concur in this view, although he declared very explicitly his determination not to form or express any opinion upon the merits of the engines until these should have been ascertained by actual trial. He informed me that so soon as all the American engines should be erected they would be placed on regular duty in comparison with a like number of British-built engines of approximately equal power and, after a lengthened period of test, the results would be fairly and impartially compared. But Mr. Johnson conveyed to me the impression that so far he was disposed to regard the American engines very favourably as likely to fulfil satisfactorily the stipulated requirements and to do good work. Nor did he seem to think that their longevity need necessarily be less than that of the British engines. When I remarked on the absence of the fluted connecting-rod and side-rods which have become so common in American practice and, indeed, in British practice also, Mr. Johnson explained that personally he preferred plain rods as giving more elasticity in rounding curves, the fluted rods being, in his opinion, although doubtless stronger, yet too rigid and unyielding, while on the other hand he did not find the plain rods, although more elastic, addicted to bending or breaking. For the rest, Mr. Johnson held that the result of the new experiment could only be learned as the outcome of protracted experience and he prudently declined to commit himself to any judgment whatever at the present stage. The engines had been obtained from America, he said frankly, because the company needed them urgently and could not procure them soon enough from any British makers. That was the whole story; its moral is in the womb of the future.

I am indebted to Mr. Johnson for the accompanying tabular statement which he was good enough to draw up, showing in what dimensional respects the American engines built at the Baldwin and

MIDLAND, BALDWIN, AND SCHENECTADY GOODS ENGINES.	MIDLAND.	BALDWIN.	SCHENECTADY.
Diameter and stroke of cylinders.....	18" x 26"	18" x 24"	18" x 24"
" of driving wheels.....	5' 2½"	5' 0"	5' 0"
" of pony	7' 2"	2' 9"	3' 0"
Centre of boiler from rails.....	160 lbs.	160 lbs.	7' 0½" about.
Pressure per square inch.....	17.5 sq. ft.	16.7 sq. ft.	16 sq. ft.
Grate surface.....	5' 11"	6' 9½"	6' 9½"
Length of firebox, outside.....	110 sq. ft.	120 sq. ft.	122 sq. ft.
Heating surface, firebox.....	1,141 sq. ft.	1,244.6 sq. ft.	1,092.7 sq. ft.
" tubes.....	1,251 sq. ft.	1,364.6 sq. ft.	1,214.9 sq. ft.
" " total.....	244	263	219
Number of tubes.....	1½"	1¾"	1¾"
Diameter of ".....	11' 0½"	10' 5¾"	11' 0"
Length over plates.....	3,250 gals.	3,250 gals.	3,250 gals.
Tender capacity.....	4' 2½"	3" 0" bogie.	4' 2½"
" wheels, diameter.....	16' 6"	14' 9" and 22' 2"	15' 6" and 23' 0"
Wheel base, engine and over pony.....	11' 0"	14' 4" and 9' 8"	12' 3"
" " tender and centres of bogies.....		centres each 4' 8"	
" " extreme.....	37' 8¼"	43' 0"	43' 0"
Length over buffers.....	49' 8½"	52' 1"	
Weight of engine, working order, pony.....	tons, cwt., qrs	tons, cwt., qrs.	
" " " leading.....	None.	7 12 3	
" " " driving.....	13 8 3	11 8 0	
" " " trailing.....	14 11 0	13 9 1	
" " " total.....	11 9 2	13 15 2	
Weight of tender.....	39 9 1	46 5 2	
" " engine and tender, working order.....	37 0 0	32 17 3	
" " " empty.....	76 9 1	79 3 1	
" " " tender, empty.....	36 1 0	41 4 5	
" " " engine and tender, empty.....	18 19 2	16 8 0	
Traction power in lbs. and tons, at 160 lbs boiler pressure.....	55 0 2	57 12 3	
	16,174 lbs. = 7.22 tons.	15,552 lbs. = 6.94 tons.	15,552 lbs. = 6.94 tons.

TABLE SHOWING DIMENSIONS OF AMERICAN AND ENGLISH LOCOMOTIVES FOR SIMILAR SERVICE ON THE MIDLAND RAILWAY.

Schenectady works respectively, for the Midland Railway, compare with and differ from the standard goods-engines designed by him and constructed at the Midland works, Derby. It will be observed that, while all three classes of engines have 160 lbs. steam pressure—the published statement that the Baldwin engines had 180 lbs. being erroneous—the Baldwin engines have 113 sq. ft. more heating surface than the Derby engines, but the Schenectady have 36 sq. ft. less than the Derby type. Both American classes have larger fireboxes and grate area than the British, but the Baldwin has more, and the Schenectady less, tube surface. Further, the Baldwin engine weighs about seven tons more than the Derby one; but the Baldwin tender, although it has an extra pair of wheels, is about four tons lighter than the Derby tender. Finally, comparing the tractive power exercisable by each engine, that of the Baldwin is 0.961 to the Derby's 1.000, and consequently that of the Derby locomotive is 1.041 to the Baldwin's 1.000. It remains to be seen how far these relative theoretical capacities will be verified by the experiences of actual practice, and how far the additional fire-box and fire-grate area of the Midland engine compensate for the comparative deficiency in nominal power.

At Doncaster I found Mr. H. A. Ivatt, the chief mechanical engineer of the Great Northern Railway, equally reticent as to his opinion upon the relative merits of the American and British methods. He mentioned that, in the engines under construction in the United States for the Great Northern main line, he had caused the sand-box to be placed below the frame instead of being on the top of the boiler as is usual in American practice. This will remove another of the differences in outside appearance and, with the domed sand-box, diamond smoke-stack, big head-light and cowcatcher all gone, there will be little to strike the casual but prejudiced eye of the average Briton as prominently non-British. This is a more important point than it may seem at first sight to be, for railway directors do not like to offend the prejudices of their customers, the British public, by any needlessly obtrusive display of "foreignism" about their locomotives or rolling stock. Thus if the American-built engines can be turned out so similar in outside aspect to the British-built article that only the eye of an expert can detect the difference off-hand, and if these engines can be supplied more promptly and more cheaply than the home product, it needs little of the spirit of prophecy to foresee that keen American competition in locomotive supply is one of the conditions with which British engineering firms will have to reckon very seriously in the near future.

Even on the point of durableness it appears by no means certain that the American product will manifest any shortcoming. "Why should they not last well?" said Mr. Ivatt, during our recent conversation. "I have been examining them and I cannot find any important part that ought not, with fair usage, to last as long, or nearly so, as those of our own engines." He added that, although the work was not so highly finished in some cases as that of an English-built engine, there was nothing in this lack of external finish that militated in any degree against the efficacy of the locomotive.

Both Mr. Johnson and Mr. Ivatt appear determined to give the American engines a thoroughly fair trial and test in every possible respect. The Americans will work, turn for turn, with British-built engines and will have every chance of showing what they can do in varying circumstances and under varying conditions. If they come out of this ordeal triumphant, then the American builders and American methods will have scored heavily and will have established a strong footing in this ultra-conservative country. And in my opinion, should that favourable result be attained, the outcome will be to place American engineering firms at least on an equal footing with British when any new engines have to be tendered for. That is to say, they will be offered an equal opportunity of competing. The mere distance and separation by ocean go for very little. All that resolves itself into a simple question of freightage. From my own experience of American engines in the British colonies, I entertain no doubt of their proving entirely satisfactory in the mother country. I anticipate that they will be found peculiarly easy on the permanent way, owing to the good services of the faithful "track-feeler," the pony-truck. A veteran British engineer, Mr. David Joy, the inventor of the famous valve-gear which bears his name, was conversing with me to-day on the subject, and he expressed that opinion very strongly, but he doubted whether the American locomotives might not be "heavier on repairs" than the British. This, however, has yet to be seen.

Regarding the whole question from a purely impartial and scientific standpoint, I cannot help feeling personally much gratification that the occasion should have at last arisen for a comparative and competitive trial of British and American methods. And I wish very much that an opportunity might offer of a similar comparison between passenger engines or express engines designed and built in the two countries. For while I do not believe that any locomotives in the world will be found to beat the British engine *in respect of performance per unit of nominal power*—power of boiler and fire-box, I mean,

as well as of cylinders and wheels—I am nevertheless convinced, again from my own colonial experience, that the American engines would hold their own very effectually and would perhaps teach us a few things which are often ignored or overlooked, but which it would be clearly to our advantage to have more forcibly impressed upon our notice.

There is no reason why the differences of practice should stand in the way. These are by no means of vital import. Some of the American peculiarities are purely superficial. Others appear to be unquestionable improvements, including the larger boilers and fire-boxes, steam-ports, and exhaust-ports. As to several there is diversity of opinion, among these being the bar framing, the equalising-levers between the springs, the outside cylinders, the valve-gear arrangement, the cast-iron wheel-centres, and the steel tubes and fire-boxes.

Some of these have already been adopted occasionally in British practice. As to the use of steel for fireboxes which has always been a matter of keen controversy, while British experience has gone entirely in favour of copper—although I believe that the Great Eastern has tried steel with some success—there is much to be said on behalf of the American method. It is contended that by the use of a single metal difference in expansion is avoided, whereas, if copper and steel be used respectively for the inside and outside boxes, they expand differently with disadvantage to the structure. Another argument employed in favour of steel is that galvanic action is not set up, as is the case when two metals such as copper and steel are used, with resultant corrosion of the plates. Further, American engineers hold that the heat of the fire is transmitted more readily to the water in the boiler through thin steel plates than through copper. Moreover, the greater facility with which thin steel plates yield between the stays without undergoing rupture when different degrees of expansion occur, is held to be in their favour. On the other hand, it is undeniable that hitherto the experience in Great Britain with steel fireboxes has not, as a rule, resulted satisfactorily. The question is clearly a moot one.

None of these points, however, present any impediment to the trial in England of express engines constructed on the American system. And such experiments would indisputedly be of the highest interest, while the outcome could hardly fail to be a valuable addition to our existing knowledge and experience in connection with the important science of locomotive-engineering.

MECHANICAL USES OF THE SCIENCE OF METALLOGRAPHY.

By Albert Sauveur.

THE physical properties of metals and of metallic alloys, to which these metallurgical products owe their great industrial importance, do not depend exclusively upon their chemical composition. They depend also, to a very great extent, upon the treatments, thermal and mechanical, to which the metals have been subjected, and if different treatments impart different properties to a metal whose composition remains unchanged, it is because such treatments modify its structure. It is therefore of as great importance to study the structure of metals, as it is to determine their ultimate compositions. The physical properties of a metal are a function of its chemical composition and of its structure, and the importance of the second factor is as great as that of the first.

While chemical analysis informs us with great nicety of the ultimate composition of metals, it throws no light upon the character of the treatment to which they have been submitted. A piece of steel, for instance, may receive a thousand different treatments and its ultimate composition remain unaltered throughout, although such treatments modify its mechanical properties. It is precisely here, where chemistry fails us, that the usefulness of the microscope asserts itself, for the microstructure of metals is extremely sensitive to slight changes of treatment. The character of the treatment is always unmistakably written in the structure; it only remains for us to learn how to read and interpret these structural changes, and to this end our efforts should bend.

The study of the structure of metals has been actively pursued for the last ten or fifteen years, in all metallurgical countries, and has called into existence a new department of metallurgy, for it has been shown that all alloys and all industrial metals (which always contain a certain amount of impurities), are made up of constituents which may be regarded as minerals, and as the study of rocks created the science of petrography, from the study of the constitution of metals was developed the new science of "Metallography."

Metallography, then, might be defined as being the science of metals with special reference to their structure.

PREPARATION OF THE SAMPLES.

Size and Shape of Samples.—Samples of metals to be examined under the microscope should not be less than $\frac{1}{8}$ in. thick, whenever practicable, and the surface to be polished should measure from $\frac{1}{4}$ to 1 inch in diameter or in side dimensions. Circular and square, or nearly square, pieces are preferable. Specimens considerably smaller or larger, however, may be handled under the microscope without much inconvenience.

If the metal is too hard to be machined, as is the case with white cast iron, spiegeleisen, ferro-manganese, hardened carbon steel, very high carbon steel and some of the so-called steel alloys, such as manganese steel, a piece of a convenient size must be broken off with a cold chisel and sledge hammer.

The surface to be examined is ground flat on an emery wheel or filed with suitable files.

Grinding and Polishing.—The purpose of this operation is to produce a surface free from scratches and from any markings which do not belong to the structure of the metal. If this has been successfully done, the metallic surface should appear highly specular. With that end in view the sample is ground very gradually by means of abrasive material of increasing fineness; the minute markings left by the last grinding being finally removed by a polishing powder. Emery is the grinding substance which naturally suggests itself. Starting with a grade sufficiently coarse to remove promptly the file marks, the specimen is rubbed in succession over two or three finer grades. The markings left by the last grinding should be sufficiently light to be speedily removed by the polishing powder. The emery may be used in the shape of emery wheels of various grades, or of emery papers, or emery cloths, or else the powder itself may be spread loose upon a suitable foundation. In the last treatment with the emery, flour emery, used wet upon a cotton cloth stretched tightly over a block of wood, will be found very effective. Jewelers' rouge of the best quality, spread upon a piece of chamois skin stretched over a piece of wood or marble, is the polishing powder universally used for the final polishing; it should be used wet. When passing from one powder to the next, it is best to rub the specimen at right angles to the marking left by the previous operation, as it can then be ascertained more readily when these have been completely removed.

The scratches left by the finest grade of emery are sometimes effaced only with great difficulty by the polishing rouge. To facilitate the work various powders, such as crocus, water-of-Ayr stone,

crushed oil stone, *brillant belge*, etc., have been used between the last emery grinding and the final polishing. The writer, however, finds tripoli powder more effective for the purpose than any of the others; it should be used wet upon a cotton cloth.

When the final polishing is conducted on a piece of soft chamois leather, with plenty of water, the various constituents, if they vary much in hardness, are not worn to exactly the same level, the harder ones standing somewhat in relief. The structure of certain samples may thus be partially revealed without further treatment, and this relief effect may be intensified by using a soft, yielding support, such as a piece of parchment stretched over a block of soft wood, thoroughly soaked and covered with very little rouge. It is, however, nearly always necessary to develop the structure of the polished surface by further treatment.

Development of the Polished Surface.—There are several methods of developing the structure, *i. e.*, of imparting to the various structural components unlike appearances, so as to make them distinguishable under the microscope.

The method most commonly used consists in etching the specimen with some suitable reagent, such as the various mineral acids, certain salts, caustic potash, ammonia, tincture of iodine, etc.

In the case of iron and steel, nitric acid, varying in strength from 1 part acid in 50 parts of water to 1 part acid in 1,000 parts of water, and tincture of iodine, yield the best results. In etching with acid, the specimen is immersed in the bath for ten or twenty seconds, carefully wiped and examined under the microscope. If it is not sufficiently etched the treatment is repeated. In etching with tincture of iodine a few drops of the reagent are poured over the polished surface and allowed to act until the liquid is quite discolored. The sample is then washed in alcohol and dried, the treatment being repeated if required. A method which the writer finds to yield very satisfactory results in the case of certain grades of iron and steel consists in dipping the specimen in strong nitric acid (1.42 specific gravity), which in this degree of concentration has no action on the polished surface. The specimen is then held under an abundant stream of running water and the acid quickly washed off. As soon as the layer of concentrated acid which covers the surface is diluted by the running water it attacks the steel vigorously, but for such a short time (since the water soon removes all trace of acid) that there is no danger of etching too deeply. One such treatment is generally sufficient to bring out the structure sharp and clear.

Metallic alloys are generally etched while being subjected to electrolytic action. The sample, resting upon a platinum plate, is immersed in a suitable saline solution, or in dilute sulphuric acid (1 part acid to 10 parts of water is recommended by Guillemin) ; the platinum plate is connected with the positive pole of an electric current, while another piece of platinum placed in the solution is connected with the negative pole. If the vessel holding the etching fluid be made of platinum, and the samples to be etched be in contact with it, the vessel itself may be connected with the positive pole. A single Daniell cell furnishes a current of suitable strength.

The structure of some metallic alloys may be brought out very satisfactorily by etching them with dilute nitric acid, caustic potash or ammonia, or even by exposing the polished surface to the action of sulphuretted hydrogen. The best treatment to follow depends, of course, upon the nature of the alloy. The preparation should be washed with alcohol after coming out of the etching bath.

The structure of a polished metallic surface may also be brought out, sometimes very successfully, by heating it gently and gradually in contact with the atmosphere, by holding the sample over a Bunsen flame for instance. The different constituents assume, in rapid succession, but with varying velocities, different shades due to the formation of light films of oxides, in such a way that at no instant of the heating are two components colored alike, the harder constituent, in the case of steel, keeping in advance of the softer one. This method, however, is somewhat uncertain and not of general application.

THE STRUCTURE OF PURE METALS.

All pure metals crystallize upon solidifying into irregular polyhedral crystalline grains. A polished and etched section will, therefore, exhibit a network structure, the fine network indicating the junction lines between the grains, Fig. 1. The dimensions of the grains vary with the temperature from which the metal is allowed to cool and with the rate of cooling ; generally speaking, the higher the temperature and the slower the cooling, the larger the grains.

When the metal is associated with a minute quantity of another metal, the foreign element appears to unite with a small amount of the main mass and upon solidification forms a membrane which cements together the grains of the pure metal, Fig. 2. Both illustrations are from drawings by Andrews. It has not yet been conclusively shown that the cementing material is the true eutectic alloy of the two metals, to be described later, but it is quite natural to suppose such to be the case.

ponent metals form neither definite chemical compounds, nor isomorphous mixtures, similar therefore to the first group of binary alloys, and he further found that the formation of their structure also follows analogous laws. This is well illustrated in alloys of lead, tin, and bismuth. If such an alloy be allowed to cool from the molten state, when a certain temperature is reached which varies with the composition of the alloy, the metal present in the greatest amount begins to solidify and continues to do so until a certain lower temperature is attained, when an eutectic mixture made up of that constituent and of one of the other component metals begins in turn to solidify, its solidification continuing on further cooling until finally, at a temperature which is independent of the composition of the alloy, the composition of the remaining portion of the liquid has reached the composition of the true eutectic alloy of the ternary alloy, which then solidifies as a whole and at a constant temperature. Like the eutectic mixture of binary alloys, the eutectic mixtures of ternary alloys are made up of extremely minute particles or plates of the *three* components in close juxtaposition.

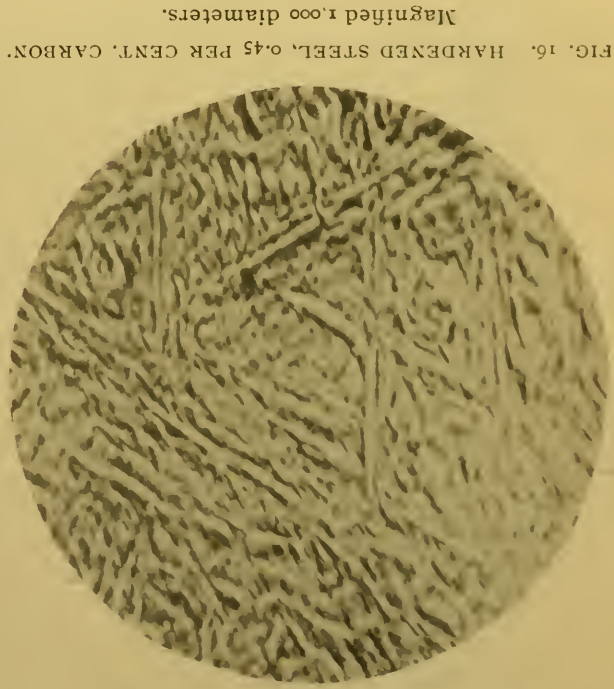


FIG. 16. HARDENED STEEL, 0.45 PER CENT. CARBON. Magnified 1,000 diameters.

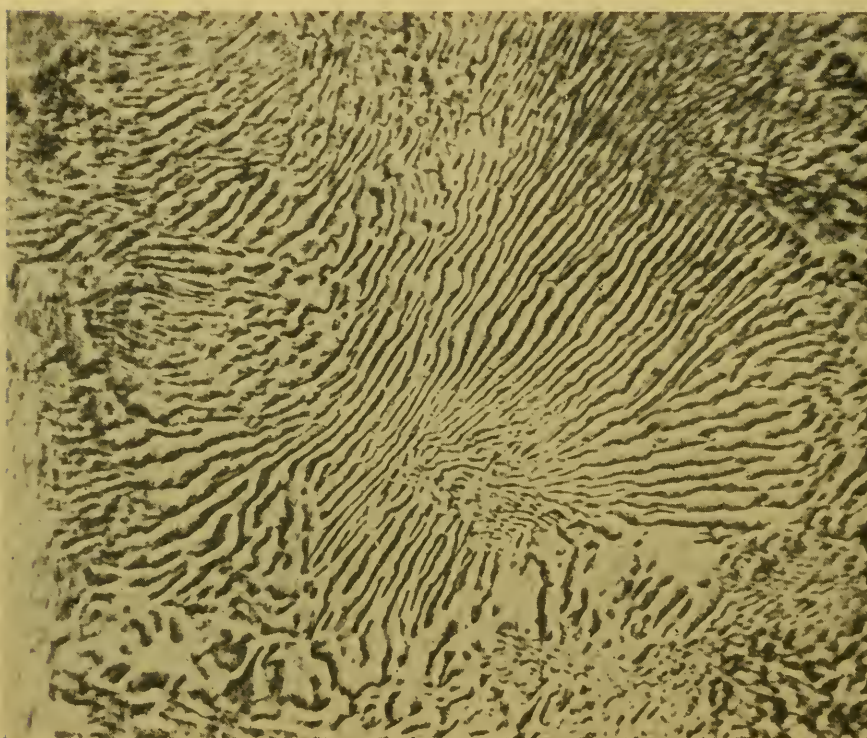
Fig. 11 illustrates the micro-structure of an alloy containing 74 per cent. of bismuth, 21 per cent. of lead and 5 per cent. of tin. The three constituents described above are easily discernible. The white structureless areas correspond to particles of pure bismuth which solidified first. They are surrounded by an eutectic mixture made up of small particles alternately of bismuth and tin, which in turn is embedded in a matrix of the true eutectic alloy, which under a high magnification is found to be composed of minute grains of bismuth, tin and lead.

M. Charpy has demonstrated the importance of the micrographic test applied to the bearing metals. He has shown conclusively that such alloys should be made up of hard grains embedded in a plastic

FIG. 15. STEEL, 1.5 PER CENT. CARBON. MAGNIFIED 1,000 DIAMETERS.



FIG. 14. STEEL, 1 PER CENT CARBON. MAGNIFIED 1,000 DIAMETERS.



it is composed, in nearly equal proportions, of pure copper (the light areas in the photograph) and of particles of the second eutectic mixtures.

To sum up, metallic alloys whose component metals form a definite compound are made up of only two structural constituents, one of them being one of the pure metals or the definite compound, according to the composition of the alloy, the other an eutectic alloy of one of the metals with the definite compound.

A small number of alloys belong to the third group, *i. e.*, their component metals form isomorphous mixtures. Upon solidifying they always form the same kind of crystals, whatever the relative proportions of the metals. The composition moreover may, according to Charpy, vary in the same crystal. The properties of such alloys have no critical point: they vary continuously and uniformly with the composition.

Alloys Made of Three Component Metals.—Until quite recently the structure of binary alloys only had been studied systematically, but M. Charpy, in some recent investigations, has examined the structure of a series of alloys made up of three constituents, mostly bearing alloys, applying to them study the methods which had been used with so much success in the case of binary alloys.

M. Charpy found a number of ternary alloys whose com-

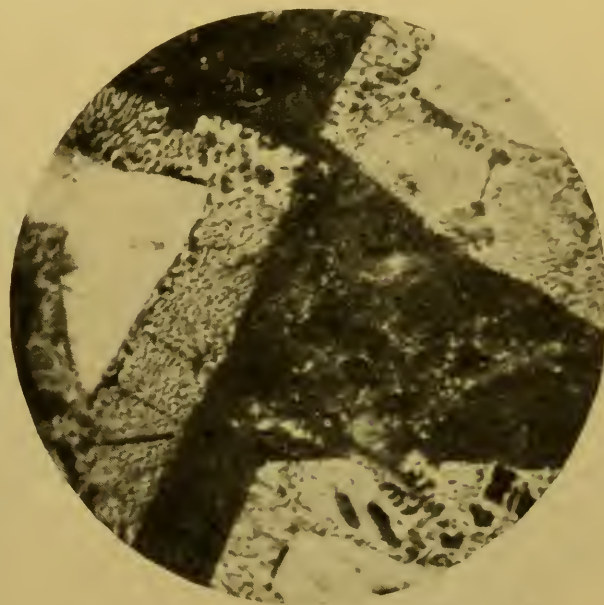


FIG. 11.
Alloy containing 21 per cent. of lead, 5 per cent. of tin, and 74 per cent. of bismuth, showing the three successive stages of the solidification.

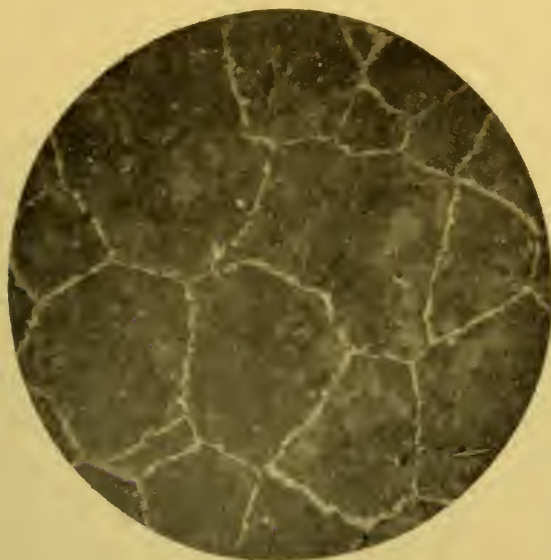


FIG. 12. STEEL OF MEDIUM HARDNESS, SLOWLY COOLED.
The membrane of ferrite is seen enveloping grains of pearlite.

MICROPHOTOGRAPHS SHOWING THE STRUCTURE OF ALLOYS OF COPPER AND ANTIMONY.

FIG. 9. ALLOY OF COPPER AND ANTIMONY.
Copper, 65 per cent; antimony, 35 per cent.
Magnified 100 diameters.

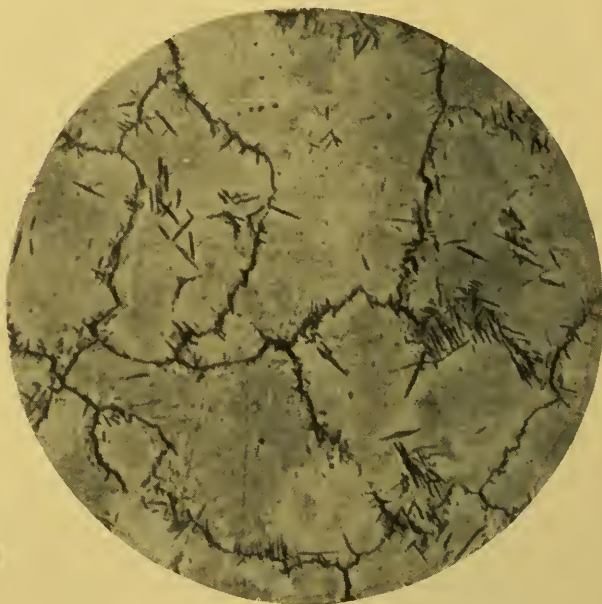


FIG. 10. ALLOY OF COPPER AND ANTIMONY.
Copper, 85 per cent; antimony, 15 per cent.
Magnified 30 diameters.



FIG. 7. ALLOY OF COPPER AND ANTIMONY, 10 PER
CENT. COPPER.
Magnified 60 diameters.

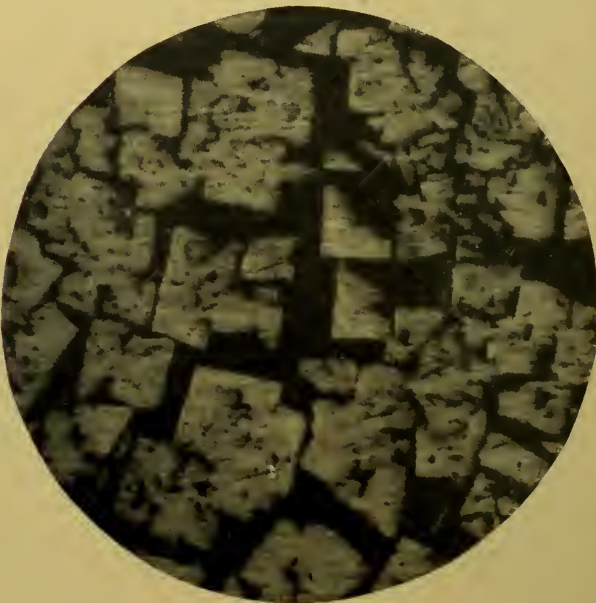


FIG. 8. ALLOY OF COPPER AND ANTIMONY, 40 PER
CENT. COPPER.
Magnified 60 diameters.



alloy contains less than 60 per cent. of copper, it should be considered not as an alloy of antimony and copper, but as one of antimony and the definite compound SbCu_2 . It will then be found that upon solidification such an alloy gives rise to the formation of an eutectic mixture made up of antimony (75 per cent.) and the definite compound. If, on the contrary, the alloy contains more than 60 per cent. of copper, it should be regarded as an alloy of copper and the compound SbCu_2 , and the formation of its structure will then be found to follow the laws which have been seen at work in the case of the first group. When a certain temperature is reached the portion remaining liquid will solidify as a whole and at a constant temperature, which corresponds to the solidification of an eutectic alloy (containing 71 per cent. of copper) made up by the close juxtaposition of particles or plates of copper and of the definite compound.

Alloys of copper and antimony, then, containing less than 25 per cent. of copper (the amount found in the first eutectic mixture) will be made up of particles of pure antimony embedded in a matrix of an eutectic alloy made up of antimony and the compound SbCu_2 ; alloys containing between 25 and 60 per cent. of copper (the percentage present in the definite compound) will be composed of particles of the definite compound in a matrix of the same eutectic alloy; alloys containing from 60 to 71 per cent. of copper (the proportion found in the second eutectic mixture) will be made up of particles of the definite compound embedded in a matrix of an eutectic alloy made up of copper and the compound SbCu_2 ; finally if the alloy contains more than 71 per cent. of copper it will be composed of particles of pure copper, in a matrix of the same eutectic mixture.

The above variations of the structure of alloys of copper and antimony are well illustrated in Figs. 7, 8, 9 and 10, reproduced from photo-micrographs by Charpy.

The alloy represented in Fig. 7 contains 10 per cent. of copper. The white portions represent crystals of antimony, the black background the first eutectic mixture. A higher magnification is required to resolve the structure of the latter. Fig. 8 shows the structure of an alloy containing 40 per cent. of copper; it is composed of violet-colored crystallites of the definite compound, surrounded by the first eutectic mixture, shown in black in the photograph. Fig. 9 exhibits the structure of an alloy containing 65 per cent. of copper; it is made up of large violet-colored crystalline grains of the definite compound surrounded by a network of the second eutectic alloy. Finally Fig. 10 illustrates the structure of an alloy containing 85 per cent. of copper;

FIG. 5. MICROPHOTOGRAPHS SHOWING THE STRUCTURE OF ALLOYS OF SILVER WITH COPPER AND ANTIMONY.

FIG. 5. ALLOY OF SILVER AND COPPER.
Copper, 65 per cent; silver, 35 per cent.
Magnified 600 diameters.



FIG. 6. ALLOY OF SILVER AND COPPER.
Copper, 66 per cent; antimony, 34 per cent.
Magnified 500 diameters.



FIG. 3. ALLOY OF SILVER AND COPPER.
Copper, 28 per cent; silver, 72 per cent.
Magnified 600 diameters.

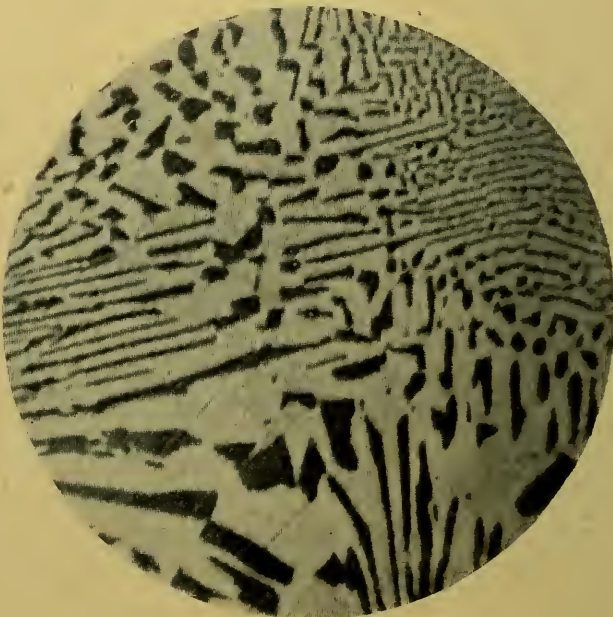
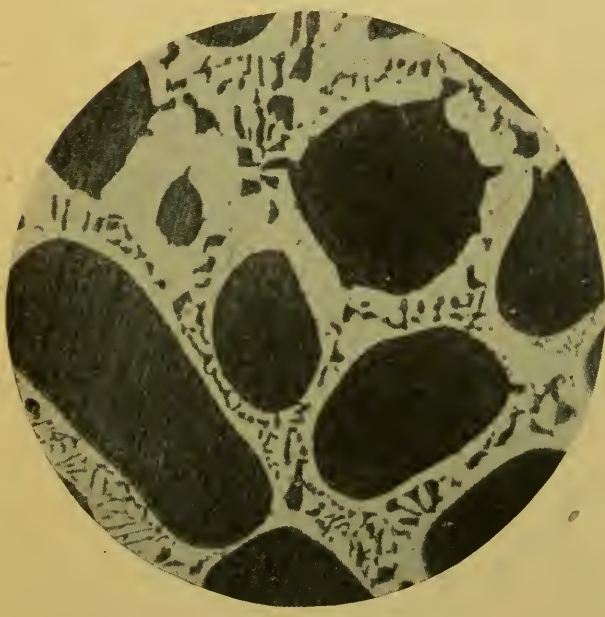


FIG. 4. ALLOY OF SILVER AND COPPER.
Copper, 15 per cent; silver, 85 per cent.
Magnified 600 diameters.



solidification of the eutectic alloy always takes place at the same temperature, whatever the composition of the alloy. Its freezing point is also the lowest possible in each series of alloys. Eutectic alloys, therefore, at once recall the cryohydrates of saline solutions.

Eutectic alloys are not definite chemical compounds; they result from the simultaneous solidification of both metals present. The microscope has shown that they are made up of extremely minute crystals or plates, alternately of one and the other component.

(On account of the minuteness of their constituents, eutectic mixtures often require very high magnifying powers for their resolution, and they frequently present under the microscope bright interference colors, recalling the appearance of mother-of-pearl.

Alloys of the first group, therefore, will be composed of crystalline particles of one of the component metals (the one present in excess), surrounded by the eutectic alloy.

As an illustration of mixtures of this character, the structure of three alloys of silver and copper is shown in Figs. 3, 4 and 5, taken from photo-micrographs by Osmond. The eutectic alloy of silver and copper contains 28 per cent. of copper and 72 per cent. of silver, and its structure is shown in Fig. 3 under a magnification of 600 diameters. It is made up of thin plates of irregular grains alternately of silver and copper. Fig. 4 exhibits the structure of an alloy containing a large excess of silver (85 per cent. silver) with regard to the composition of the eutectic alloy. It is composed of large rounded grains of pure silver surrounded by the eutectic alloy. The structure was made apparent by heating the preparation to a purple color, which accounts for the dark appearance of the silver. In Fig. 5 we see the structure of an alloy containing an excess of copper (65 per cent. copper); it is composed of large areas of copper, surrounded by some eutectic alloy whose characteristic structure is sharply defined.

In Fig. 6, reproduced from a photo-micrograph by Charpy, is shown another typical instance of the peculiar constitution of eutectic alloys. It represents an alloy of silver and antimony containing 66 per cent. of silver, *i. e.*, an excess of that component corresponding to the white areas in the illustration.

In order to understand more readily the formation of the structure of alloys of the second group, *i. e.*, whose component metals form some definite chemical compounds, let us consider an individual case—that of antimony and copper alloys.

Copper and antimony form a definite compound answering to the formula SbCu_2 and containing about 60 per cent. of copper. If the

THE STRUCTURE OF METALLIC ALLOYS.

Alloys Made Up of Two Component Metals.—The modern theory of binary alloys, so brilliantly worked out, notably by Dr. Guthrie, H. I. Chatelier, Heycock and Neville, Sir William Roberts-Austen, Charpy and Gautier, classifies all such mixtures into three classes:

- I. Alloys whose component metals form neither definite chemical compounds nor isomorphous mixtures.
- II. Alloys whose component metals form definite chemical compounds.
- III. Alloys whose component metals form isomorphous mixtures.

When an alloy of the first group is allowed to cool from the molten state, it gives rises, on solidifying, to the formation of a structural constituent of *constant composition* whatever the proportions of the

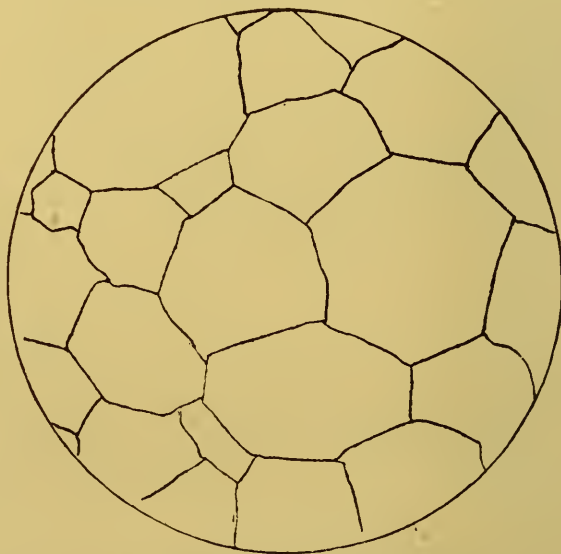


FIG. 1. PURE GOLD, MAGNIFIED 100 DIAMETERS.

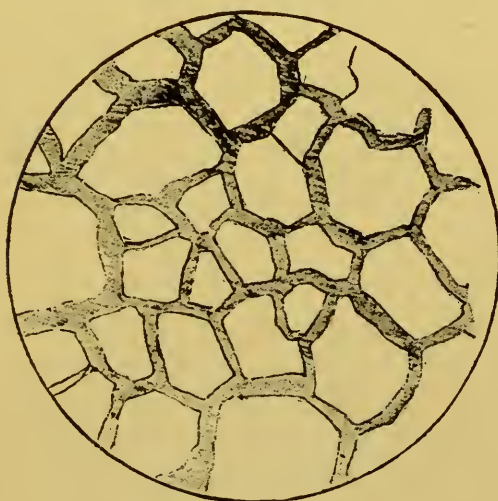


FIG. 2. GOLD WITH 0.20 PER CENT. OF LEAD, MAGNIFIED 100 DIAMETERS.

two metals in the alloy. It is called the *eutectic alloy*, a name proposed for it by Dr. Guthrie. Unless the alloy, therefore, has exactly the composition of the eutectic mixture, it contains an excess of one or the other metal. On allowing the molten alloy to cool, when a certain temperature is reached, which temperature *depends upon the composition of the mass*, the metal in excess begins to crystallize and continues to do so on further fall of the temperature, until the remaining portion of the liquid, which becomes all the while poorer in the metal present in excess, has reached the composition of the eutectic alloy. At that instant the temperature ceases to fall, and the remaining liquid, *i. e.*, the eutectic alloy, solidifies as a whole and at a *constant temperature*. The

matrix, and it is only with the assistance of the microscope that it can be ascertained whether they possess the required structure.

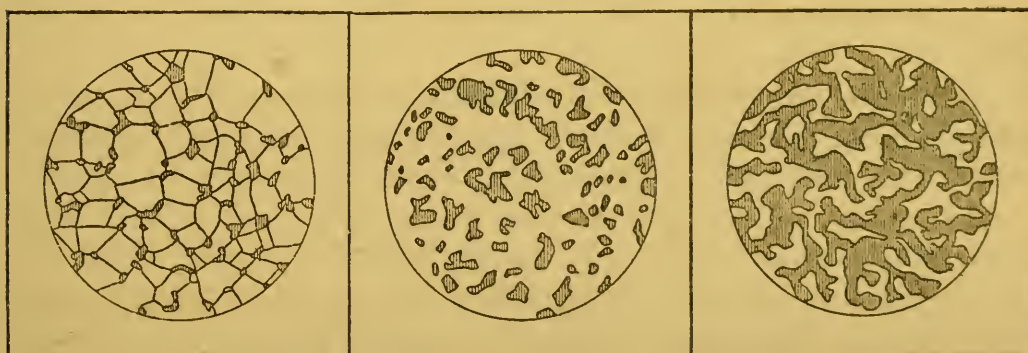
THE STRUCTURE OF IRON AND STEEL.

Pure Iron.—Like all pure metals, carbonless iron is made up of irregular, polyhedral, crystalline grains, which vary in size and shape with the treatment to which the metal has been subjected.

Unhardened Steel.—Steel in its unhardened condition is made up of three microscopical constituents, only two of them however being ever present in the same sample.

I. *Ferrite.*—This is iron free from carbon. It constitutes, of course, the totality of carbonless iron and decreases in amount as the percentage of carbon in the steel increases. With a carbon-content of about 0.80 per cent. there is no ferrite in the steel (see Plate I).

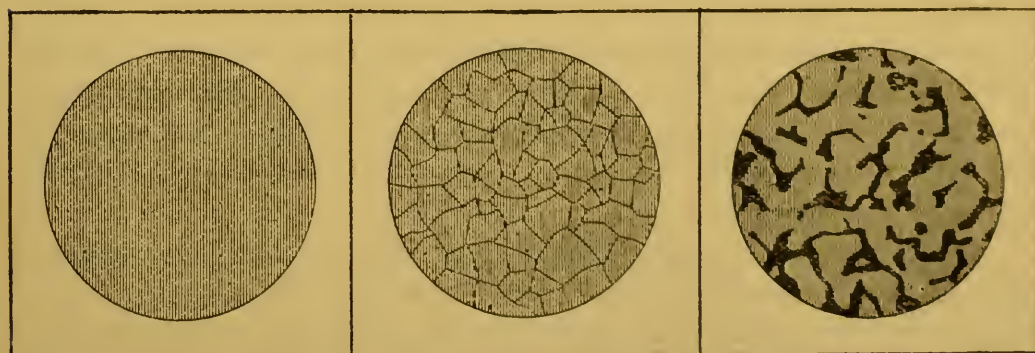
When present in considerable quantity, as in iron and soft steel, it segregates in relatively large masses and crystallizes in polyhedral grains (see Plate I Fig. A). In the drawings the ferrite is left white, the black net-work showing the junction lines between the grains. In



A. Carbon, 0.09 per cent.

B. Carbon, 0.21 per cent.

C. Carbon, 0.35 per cent.



D. Carbon, 0.80 per cent.

E. Carbon, 1.20 per cent.

F. Carbon, 2.50 per cent.

PLATE I. SERIES SHOWING THE MICROSTRUCTURE OF UNHARDENED STEEL.

The clear areas are ferrite, the cross-lined pearlite, and the black areas cementite. The series shows admirably how, as the carbon increases, the ferrite disappears and the pearlite increases until, at 0.80 per cent. carbon, the entire mass is pearlite. With a further rise of the carbon-content, the pearlite in turn gives place to the gradually increasing cementite.

Fig. B, these junction lines are not indicated. In steel of medium hardness, slowly cooled from a high temperature, the ferrite, present only in small quantity, forms a membrane of varying thickness enveloping the grains of another constituent to be described later (pearlite), Fig. 12. If such steel, however, be forged until a relatively low temperature is reached, or if it be reheated to a low temperature, both constituents are more thoroughly mixed, presenting a confused and amorphous appearance. Finally ferrite forms a structural element of pearlite, as will be seen later on.

A slight etching of the polished section leaves the ferrite white and brilliant, and develops the joints between the grains. On etching more deeply, however, some of the grains are darkened or assume a mottled appearance, while others remain bright. Ferrite being the softest of all the constituents is more easily worn away by polishing, being frequently somewhat depressed with regard to the other components.

II. *Cementite*.—This is a combination of iron with cement-carbon, *i. e.*, carbon as it exists in unhardened steel. It answers to the formula Fe_3C .

Cementite begins to appear when the carbon-content rises above 0.80 per cent., immediately after the disappearance of ferrite, and increases in amount with further increase of carbon. When present in large quantity, as in very hard steel, it segregates in relatively large particles, (see Plate 1, Fig. F.). In the drawing of Plate 1 the cementite is shown in black to distinguish it from ferrite. When present only in small quantity, it frequently forms thin membranes around grains of the third constituent (pearlite), as shown in Plate 1, Fig. E. Cementite, like ferrite, constitutes a structural element of pearlite. Cementite remains bright and brilliant, even after repeated etchings. While ferrite is the softest, cementite is the hardest of the constituents, so that it generally stands in relief, especially if the polishing be finished on a soft, yielding support. Cementine, moreover, always remains structureless.

III. *Pearlite*.—A magnification of at least 300 diameters is generally required to resolve the structure of pearlite. It is then found to be made up of minute particles or very thin plates, alternately dark and bright. It is known beyond any reasonable doubt that these components of pearlite are ferrite and cementite. If the steel has been allowed to cool slowly and undisturbedly from a high temperature, pearlite assumes a well defined lamellar structure. If on the contrary, the metal has been forged down to a low temperature, or reheated to a

relatively low temperature, pearlite assumes a granular appearance.

The amount of pearlite in steel increases proportionately to the carbon-content displacing ferrite, until at about 0.80 per cent. of carbon, it forms the totality of the mass. With further increase of carbon, cementite begins to replace some of the pearlite (see Plate I.). With low powers, pearlite appears dark or gives rise to a beautiful play of color, strongly suggestive of mother-of-pearl, hence its name. A high magnification, as stated above, is needed to reveal its composite structure.

The structure of samples of steel made up respectively of ferrite and pearlite, of pearlite alone, and of pearlite and cementite, is further illustrated, under a magnification of 1,000 diameters, in Figs. 14 and 15, which are reproduced from some beautiful photo-micrographs by Osmond. The laminated structure of pearlite is clearly brought out, and in Fig. 15, it may be readily seen that the cementite (the white portions), stand in relief; the surrounding pearlite, being softer, has been worn away to a greater extent by the polishing operation.

The great similarity which will be seen to exist between the structure of steel and that of binary alloys which form neither definite compounds nor isomorphous mixtures, leads us to consider steel as an alloy of iron and the carbide Fe_3C , *i. e.*, of ferrite and cementite, pearlite being the eutectic alloy of the two components.

The similarity of their cooling curves, whose description however, is beyond the scope of this paper, greatly increases the analogy between steel and other alloys. There is, however, one point in which steel differs materially from ordinary metallic alloys. In alloys the crystallization of the constituents takes place simultaneously with their solidification. Above the point at which crystallization begins, the mass is *liquid*. With steel, on the contrary, the crystallization of the constituents takes place while the whole mass is already *solid*. At a high temperature steel is a *solid solution* of the two components, iron and Fe_3C , which upon further cooling crystallize out, exactly as the component-metals of an alloy crystallize during solidification.

Hardened Steel.—When a piece of steel is suddenly cooled from a high temperature, unless it be very slightly or very highly carburetted, it is found to be made of a single constituent, which has been called “martensite,” the structure of which is illustrated in Fig. 16, under a magnification of 1,000 diameters. It appears to be made up of needles frequently crossing each other. The hardness of martensite increases rapidly with the carbon-content and becomes very great.

From what has been said it would seem as if martensite must be that solid solution of iron and the carbide of iron, Fe_3C , existing at a high temperature, retained in the cold metal through sudden cooling, the components having been denied the necessary time to crystallize out.

If the steel contains very little carbon, a small amount of ferrite is found associated with the martensite, while if it be highly carburized some cementite is found in the metal after quenching.

While the structural composition of metals and alloys is regulated by their chemical composition, it is evident that their physical properties, to which they owe their prominent place in the arts, do not depend exclusively upon the relative proportions of the structural components, but that they depend also upon the distribution, mode of occurrence, size and shape of the individual grains or crystalline particles, and these features are regulated by the treatment, thermal and mechanical, to which the metal is subjected.

The microscope gives us a means of studying these structural changes which are so closely related to the properties of the metal, and thus opens up possibilities in the art as well as in the science of metallurgy whose value can hardly be overestimated.

EDITORIAL COMMENT

Mr. Barrett's article on the far eastern situation, which leads this issue, is inspired by the conviction that the engineering world has the largest interest, and can and should exercise the largest influence, in the settlement of the Chinese question and the attendant problems in eastern Asia.

This is "the new diplomacy"—the striving for expansion of industry, not for the extension of power. It should be plain enough to the industrial world that it must concern itself actively in the matter, and yet its eyes are still dim, its ears still dull, and its voice low or uncertain.

This is more particularly true of the United States; the Briton and the German have been going abroad so long, making the harbours, building the roadways, and opening the mines of the world, that they lead, rather than follow, their governments in the matter of foreign policy. But if America needs to appreciate the irreparable loss which will follow present inaction, England and Germany need to understand that they have far more to gain than to fear from America's entry into the question. The needs of the newly-opening regions of the earth are going to tax—and overtax—the producing capacity of all the industrial nations. There will be wholesome competition for the units of their requirements, of course, but the aggregate will be so great that no one, nor two, manufacturing nations can supply them all. And they must all be supplied, if the development is to go on at all.

But first, stable conditions and an equitable policy must be established throughout the region, and this will never be secured by a savage scramble for fragments of territory or limited "spheres of influence." Will the industrial elements of England, America, and Germany, whose interests are paramount, see in time that these interests are identical and demand from their governments identical action for the preservation, in its entirety, of their undivided interest in the greatest market the world has ever known?

Mr. Orcutt, (whose remarkable articles on Machine-Shop Management, in the pages of this Magazine, have awakened an interest living far beyond the close of the present series), is an apostle of the new school of works management, in which the comfort of the worker is a ruling principle. He preaches, however, by his own avowal, not as a humanitarian but as an economist.

To quote his own humorous phrasing of it, "We don't do it because we love our fellow man, but because it pays." In his August article he put it thus: "As a means of securing and retaining the best workmen, the best appliances for their accommodation and comfort become, of course, a necessity." This is a recognition of the second stage—appreciation by the workers of their improved surroundings. Already the manufacturing world is emerging from the darkness wherein the employer said: "Let them keep warm by working harder"; where the railway put the engine driver on an uncovered foot plate, "Lest he should go to sleep" in quarters made too comfortable. The dark ages have lasted longer in Europe than in America, but they are passing—not, perhaps, because we love our fellow man any better, but because we understand better that "it pays" to reduce waste, wear, and tear—of body and mind, as well as of steam and metal-bearings—of workmen, as well as of work-tools.

* * *

The works manager who "treats his men like machines" has long been held up to execration. But now, with a changed conception of what the phrase implies, it promises to become the ruling idea of the best shops—those in which the men are treated with the greatest apparent consideration.

Not to consider that a man is a machine—fully automatic, driven by an individual motor (in fact, by a complete isolated power plant), capable of a very wide range of work, but very sensitive to bad handling—has too often meant to give to his setting and up-keep far less care and attention than are bestowed on the comparatively rough

and coarse tools of metal. A manufacturer who refused scornfully to heat his work-rooms for the sake of the employees, has been known to agree at once to install a warming and ventilating plant when reminded of the advantage to some accurate metal-cutting tools.

The selfishness which was indifferent to the workman's well-being, because workmen apparently cost nothing to install and could be replaced without apparent cost when worn out, was blind not to humanity merely but to its own pocket interest. Installation expense, as a rule, makes but a small factor in total cost, in comparison with the fraction chargeable to operating expense; operating expense is best reduced by increasing output; increased output can be secured only by working a machine under advantageous conditions. The human machine, to attain its maximum output, needs reasonable warmth and light, cleanliness, oxygen, and nourishing food. It needs also certain less tangible elements—called by some writers "sympathy"—which have more or less effect upon that elusive part called its "ambition."

Strange that managers, eager for the utmost of economy in the power plant, keen to increase the efficiency of machine tools, should be so slow to realise the importance and the profit of proper care and up-keep of the human portion of their producing machinery.

* * *

The certain sequence of trust-formation is beginning to appear in the United States, in the form of new concerns organised to fight the big combinations. Even where these latter are as large and as powerful as those which have been formed in the iron and steel trades, courage to compete seems not to be lacking.

Stimulus to such efforts is, of course, afforded by the sudden rise in the wave of industrial activity which has spread over the States. The conditions which prevented English firms from making early deliveries of locomotives, and of other orders recently placed in America, seem now to rule throughout the United States. The demand falls ultimately upon the iron and steel makers, and their capacity is, for the present, overtaxed. Much of the work now under way or projected has been waiting

through recent years of depression and economy, and is badly needed. Whether the boom will survive the approaching presidential campaign, however, remains to be seen. It will at least be a time of stern trial for the recently-formed industrial combinations.

* * *

Mr. Rous-Marten speaks of the growing tendency, apparent in locomotive practice, for distinctively national differences in construction to disappear. "The distinctive features of the British and American systems are now but few. Their tendency is to become fewer still." And this is but an instance of a movement which, in its full range, extends throughout every department of engineering work.

With the increase of travel, and the attendant freer interchange of observation; with the extension of engineering literature; more than all, perhaps, with the meetings in exploitation work in new countries and the competition for export trade, engineers everywhere are learning the expediency—more, the necessity—of drawing upon the common fund of experience where it is at their disposal, in place of toilsomely amassing a private store of their own.

This does not imply, by any means, that practice is nearing a dead level of monotony. On the contrary, the opportunity for advance and for individuality is as much greater as the international field is wider, and the international emulation is keener, than the national. With the restrictions of local limits and local prejudice broken away, there is opportunity for such progress as has never yet been realised. But we shall hear less about "English practice," "German practice," "American practice"—and more about *good* practice.

And it is the aim of THE ENGINEERING MAGAZINE to further this movement by making its pages, not the depository of any single national fund of engineering knowledge, but a clearing house into which the funds of all are paid, and in which the totals are determined and the balance struck.

* * *

It is supposed to be one of the advantages of association among professional men that they learn something about each other's work, or at least about its nomenclature;

and, while possibly not always working in entire harmony, they are supposed to avoid such use of identical terms for different things as might cause confusion. That this is not always the case, however, appears in one or two decidedly unfortunate instances.

It might have been supposed that, if there was any one term about whose status there was no manner of doubt, it was the British Thermal Unit, the well-known abbreviation for which is in world-wide use as B. T. U. Now, however, along comes a much later term, having an entirely different meaning, and a good name of its own, *i. e.*, the kilowatt-hour, and not only gets itself entitled the "Board of Trade Unit," but actually has the effrontery to appropriate the time-honoured initials, and behold there is another "B. T. U." in the field. If the two units were used in widely separated lines of work there might be less cause for objection; but, since mechanical and electrical engineering continue to draw closer and closer together, the continuance of this confusion in nomenclature ought to be stopped. The pirate term has not been in use so long that it may not be ousted from its usurped position, especially as it is employed by only a portion of the English-speaking people; but the sooner its use is discontinued, the easier it will be to get rid of what never should have been permitted.

* * *

There is another confusion of meanings for a single term, for which, however, there is a better excuse, as both meanings really refer to the same action, though under different conditions. The word electrolysis, long used in electro-chemistry for electrical decomposition, has been appropriated by the electric-tramway fraternity to indicate the corrosion to water mains caused by stray currents. While this is undoubtedly a form of electrolytic action, it is a destructive form which is distinctly different in general character from the industrial or analytical operations of refining works, of the electrotypers, or of the laboratory. Rusting might very properly be called oxidation, yet it is rarely so dignified, and the electric corrosion, which unfortunately occurs too often as a result of defective rail-bonding, ought to be called by some name more indicative of the fact that it is an unintentional and injurious process.

While upon this subject of names, the question of the proper word to use for a self-propelled vehicle demands attention. Many individuals and publications appear to think that it is necessary that some new word be coined for such vehicles, to indicate that they form a class by themselves and are something distinct from the horse-drawn article. There was good reason to object to the term "horseless carriage," but that awkward term has practically died a natural death, and automobile seems to be the term in favour. But why should there be any specific term, any more than there is to indicate that a horse, a mule, or an ass, is the source of motive power for the older vehicle? Different kinds of carriages have different names, regardless of the nature of their motive power; and if, as many believe, the animal will soon be superseded by the machine, there will be no need to explain that he is not there, since no one will expect him. Let the old names for the various kinds of wheeled vehicles stand, and let the method of their propulsion take care of itself, or be indicated by response to further inquiry.

* * *

There is a feature appearing in connection with the introduction of electric driving in machine shops, which, although a part of the natural evolution of the subject, has not received the attention it deserves. In former days, and, indeed, not so very long ago, the whole question of machine-shop design and tool arrangement depended upon the motive power. Great works were laid out upon the basis of the location of the engine house, and long lines of shafting formed backbones, along which all sorts of tools were arranged in order that they might get their power to the best advantage. Heavy tools were placed near the source of power, and machines had their location determined by the question of the pull of belts rather than by the work to be done; and, in spite of all, the loss involved in getting the power to the point of action often amounted to 50 per cent. of the whole.

When a new works is to be designed, and electric driving is adopted, the whole basis of action is changed. Instead of the motive power being the prime consideration, it drops into the background, and the estab-

lishment **can** now be planned, as it should be, with regard to the work it is to perform and with respect to the output. Machines can be arranged in some sort of logical sequence; it is no longer necessary to place the lathes lengthwise of the shop, merely because the line shafting happens to run that way. If the opportunities for efficient operation which this new order permits are fully appreciated, the advantages possessed by a newly erected works ought to be sufficient to give it a lead hardly to be overcome by its older competitors.

* * *

In these days of standards and standardization it is most desirable that practice should be made as nearly international as possible, in order that records of work in various parts of the world may be directly comparable. The International Association for Testing Materials is doing good work in its various lines, and offers an excellent example to be followed in other directions.

There is now a fine opportunity to do either the right or the wrong thing in the matter of testing engines and boilers, and it is to be hoped that the question will be given a chance to reach a proper settlement. There is a committee for the revision of the code for testing steam boilers, composed of members of the American Society of Mechanical Engineers, and it has done much good work, and made several partial reports, while another committee of the same society is preparing to report upon a standard method of testing steam engines. At the same time, the Institution of Civil Engineers has a Thermal Efficiencies Committee at work upon practically the same subject, and, unless some means be devised to effect a co-operation of these two bodies, there must be two independent reports presented and adopted. There certainly appears to be no good reason why the committees of two representative bodies of engineers, practically standing for the science of steam engineering of the Anglo-Saxon world, should not get together and harmonise the details of their work, and present codes which should stand the world over.

At the present time the horse-power stands as a unit in all countries, not because it harmonises with the metric system,

but because it is the measure used by the nations who build the steam-engines of the world, and there is little reason to believe that any other standard of engine and boiler performance could find acceptance beside the one adopted by the engineers of England and America. It is to be hoped that this opportunity will not be lost, and that we shall have a harmonious, and not a conflicting code. Such a conference between French and English scientists a hundred years ago might have given us a metre only $\frac{5}{8}$ of an inch longer than the present one, and all would have been harmony instead of confusion in another line of work.

* * *

The very interesting experiments recently made in France upon the resistance of glass to tension, of which a fuller review is given elsewhere in this issue, is an excellent example of the manner in which the practical experience of centuries discovers what the scientists can only learn in the laboratory. It has long been the experience of bottlers of champagne and carbonated waters that bottles which have been under pressure for some time are apt to burst without rule or reason; and without attempting to explain the fact, the experienced bottler objects to the use of old bottles as being more likely to give trouble in this respect. Now comes the scientist and proves, by tests in his laboratory, what the bottler long ago knew. He shows that glass, when subjected to a stress for a long period of time, becomes perceptibly weaker and may at last yield to a load which was at first sustained with ease.

It will often be found that there is a scientific basis for a popular belief, and this is but another contribution to the truth of this impression.

* * *

By an unfortunate oversight, the concluding paragraph of Mr. David A. Louis' paper on the Magnetite Deposits of Swedish Lapland in our July issue was omitted. The few omitted words contained the titles of the last three illustrations, and called attention to the fact that these views are from the Ural, and do not represent places in Lapland. They show very effectively the close resemblance to the methods of mining and transport in the two places, and round out the description of northern mining methods.

REVIEW OF THE BRITISH PRESS

An American Machine Works in England.

THERE has been so much written and said of late about American methods and American tools that the subject is almost worn threadbare. It will now no longer be necessary to journey across the Atlantic to investigate the conditions under which American machine works are operated, since a full fledged American machine shop will soon be in active operation in England. We refer to the new works of the Westinghouse Electrical Company about to be erected at Trafford Park, on the margin of the Manchester Ship Canal, and a description of these works is given in a recent issue of *Engineering* with some interesting comments on the conditions which have led to their construction and which will attend their operation.

Commenting on the changes which have taken place in connection with the operation of machine works, *Engineering* says:

"Day by day business methods are changing; they do not alter because we say so, but as the result of vast forces which are beyond our control and insensible to our influence.

"Economic laws are not made in Parliament, where powerful sections of the community can get clauses inserted defending their interests. We see them gradually coming into action, and those whose eyes are not blinded can sometimes predict the lines of their development for a short way ahead. "Hitherto we have never said that the wolf of American competition had come, although we have proclaimed that it was surely coming." Now it appears in the form of a British manufactory dominated by American ideas, and few who study the signs of the times will fail to appreciate the importance of the news.

It is not often that an enterprise starts under such auspices as does the English works of the Westinghouse Company. Beginning, so to speak, with a clean sheet, it has behind it all the experience gained in connection with the successful operation of the great works at Pittsburgh, while at the

same time it is hampered by none of the conservative traditions which have so much influence over the conduct of old-established English concerns.

"The new firm will not start as a beginner who has to feel his way step by step. It will inherit all the patents, drawings, and records of the parent company, and there will be transferred to it the entire accumulated experience of the Pittsburgh undertaking. In all cases of difficulty it will command the assistance of a staff which has demonstrated its ability in competition with the best engineers of America, and thus will be able to undertake risks which would be full of hazard without this aid."

It will of course be understood that in this new works specialisation will be carried to its logical conclusion. The new establishment being in England will be nominally an English works, but in fact it will be an American shop, transplanted, it is true, but still distinctively American. British labour will be employed, but it will be employed on American tools, and operated on American methods. We venture to affirm that the output of the American tools in this establishment will be fully as great as is obtained from similar tools in the land of their origin; and we may further affirm our belief that the men operating them will learn that their wages will depend upon the product of the machines under their care.

There is one thing which the American manufacturer has learned which labour conditions in England have not permitted to be developed in Great Britain, *i. e.*, the fact that it is the wages cost per unit of product that must be considered, and not the wages per unit of producer. It matters little how much money the workman makes provided the cost per unit of product is diminished. Hence the strenuous aim of the American manufacturer is to increase the total output per man, and to do this he arranges and adapts his machinery to obtain as great an output of work with as few men as he possibly can.

Everyone who has visited an American

machine shop has observed how few men proportionally there are in it compared with similar establishments in other countries. One man attending to two, three, or four machines is a most usual occurrence, and in most cases the one man is not working as hard as he would have formerly been attending a single machine, while at the same time he is earning higher wages. If such methods can be successfully introduced into England, they will demonstrate most forcibly both to English employers and English workmen that the old-time methods can no longer be continued.

"In warning our readers against the perils of American competition, we are preaching no original doctrine. There are many firms who saw the danger years ago and who guarded against it. We could name shops where all that is good in American practice has been assimilated and modified to meet British needs, where no machine-tool is retained after it is out of date, and whose owners can face foreign competition in any market where they have a fair field. It is our boast that Englishmen never know when they are beaten, but it is a saying that can be read two ways. Wilful ignorance of danger is no safeguard, and blind neglect gives no augury of victory. We have still abundant capital and great skill, but we are handicapped by our conservative instincts. There are too many among us who grumble that they should be obliged to change their ways, and cling with desperation to their old methods. They are just in the position of the old-fashioned tradesman who refused to learn the cheaper methods of the stores and prided himself on his aristocratic connection, until he awoke one day to find that it had left him. It is, indeed, a hard task to revivify a failing business, and we would warn our readers against getting into the position of having to attempt it. There is no secret about modern methods; he that runneth may read them if he will."

Automatic Couplers.

THE agitation in connection with the question of the use of automatic couplers on railways appears in the form of various articles in the technical press, the *Engineer* especially devoting much space in several issues to the subject. In addition to verba-

tim reports of the sittings of the Royal Commission, there is a report upon the use of automatic couplers on American freight cars and a very complete and lucid account of the manner in which such couplings have been introduced in the United States.

Since the practice in America is being extensively referred to as a precedent for the introduction of automatic couplers in Great Britain the conditions which led to the successful realisation of the matter in America are certainly worthy of study.

The introduction of automatic couplers was not accomplished on the American railways without much opposition, and indeed all the freight cars are not yet fitted out with them, but by law the complete equipment of all the railways must be completed by the first of next January, and the means by which this has been accomplished are of interest. For many years there had been a direction of inventive talent towards the subject of couplers, so much so that the records of the Patent Office teemed with all sorts of devices, good, bad, and indifferent, all endeavouring to win the great prize which must fall to the inventor whose device should be adopted. It was the prolific nature of the subject which did much to delay the introduction of any of the devices, since nearly every inventor failed to realise that interchangeability was the one essential which must be secured. In the United States the cars must pass from line to line, and be made up in trains from every part of the country, and unless the coupling devices on a car would enable it to form a portion of a train of cars of other lines than its own, they would be useless.

It is evident that some standard form must be adopted, at least so far as the shape of the connecting parts is concerned, although there is no particular reason for the other features of the mechanism being the same on all cars. It was the necessity for uniformity of actual coupling parts which led the Master Car Builders Association to adopt the so-called Janney type as the standard, and as the owners of the Janney patents waived their patent rights on the form of knuckle and coupling-head, this paved the way for the introduction of interchangeable couplers. This was followed by the petition of the brakemen to the Interstate Commerce Commission, and

the subject was commented upon in the President's message in 1889. In 1893 the "brake and coupler act" was passed, requiring all cars to be equipped with automatic couplers before 1898, but at the expiration of this time it was found to be necessary to grant an extension of time to January 1st, 1900, and semi-annual reports as to the progress of the work of equipment were required. More than 80 per cent. of the cars are now equipped, and the work will doubtless be completed by the expiration of the time limit.

The result of this enforced introduction of automatic couplers is a demonstration that the couplers are not only desirable from a humanitarian point of view but are also very advantageous for operative reasons. This is especially true when the trains are also equipped with air brakes, and there is no doubt that trains fitted with continuous brakes and tight couplers can be run at higher speeds over steep gradients with less fear of their breaking apart than was possible with the old pin and link coupling. The greater facility with which trains can be made up and handled forms an important element of economy, and the absence of waste energy in bumping and jerking the cars, so apparent with the old loose couplers, is avoided, and a saving in power and a reduction in wear and tear naturally follows.

The experience which has been had in America in this important subject should be considered in all its bearings in connection with the question as it has come up in Great Britain. It is really only one form of the whole broad subject of re-equipment of works about which so much has been said of late. To argue against a manifest improvement simply because it means a large outlay and a superseding of existing plant will not do. It is just such arguments which have kept many obsolete devices in operation long after they have outlived their usefulness, and it is a consequence of such mistaken policy that we find so many things in use to-day which should long ago have gone to the scrap heap. The true question should not be, "can the railways afford to have their cars equipped with continuous brakes and automatic couplers," but rather, "can they afford longer to go without so equipping them?"

The Irish Channel Tunnel.

THE revival of the scheme for a railway tunnel to connect Ireland with England has been the occasion for various articles in the engineering journals, and an editorial in the *Engineer* discusses the subject in a characteristic manner.

The political side of the question appears in the proposal that the British Government guarantees the interest of 3 per cent. on £12,000,000 for an indefinite period, and while this has nothing to do with the engineering features of the scheme it shows that some other inducement than that of the prospect of immediate returns from the operation of the tunnel is thought necessary.

Apart from the political side of the subject, the tunnel may properly be regarded as a matter of engineering, and as such the scheme demands consideration from the engineering point of view. Unfortunately the promoters have presented little or no information upon which an engineering opinion can be based.

"Lord Charles Beresford has been credited with saying that so long as money enough was forthcoming engineers could do anything. We fear that he has formed rather an exaggerated estimate of our powers. We are quite unable, at all events, to say whether the proposed tunnel could or could not be made, simply because no positive information on a most important point is available. No one knows what faults exist in the bottom of the channel. It is proposed that the railway shall pass 150 feet below the sea bottom. No borings have been made in mid-channel. The whole region manifests signs of violent volcanic action. The construction of the tunnel would be commenced absolutely in the dark as to the condition of the strata to be passed through; how far it is fissured, how far saturated, no one has any accurate information."

Under these circumstances it is rather difficult for any engineer to form an opinion upon the cost, or even the possibility of the construction of a tunnel under the Irish Channel, and until such information is forthcoming, no estimate of the probable earnings can well be made. The only thing under the circumstances which can be done is to make a comparison between the pro-

posed route by tunnel with existing means of transport, and see what the present competing conditions are. This has been done by the *Engineer* in a manner which shows the advantages of a tunnel, so far as saving in time is concerned to be very slight. Taking the time by railway from Belfast to Dublin at 2½ hours, by boat from Dublin to Holyhead at 3 hours, and the run from Holyhead to London at 6 hours, we have Belfast now placed within 12 hours of London, or allowing for contingencies the time may be placed at 13 hours, regularly.

The tunnel scheme involves a tunnel about 30 miles long, and the time required for the run can safely be put at one hour, while the terminal in Scotland would be at some point not less than 414 miles from Euston. Allowing 10 hours for this run, and one hour for the time from Belfast to the tunnel entrance, we have 12 hours for the entire distance between Belfast and London, or only one hour saved by the tunnel over existing means of transport. Since the Irish railways are of a different gauge from those in England through trains cannot be run, and the difficulty of breaking bulk and reloading appears in the tunnel plan as much as it now does in the water route. Taking all these conditions into account it certainly appears as if some extraordinary inducements other than those yet offered should be shown before any such expenditure as £12,000,000 would be warranted.

It is certainly worthy of note that when land transport exists, advocates are always ready with some plans for the opening of water communication, and that, on the contrary, when water transport is already naturally available, either bridges or tunnels are as actively urged. Both doubtless have their advantages, but wherever one of them already exists, there advocates will always be found to urge the construction of the other.

The Launching of a Battleship.

THERE have been many articles and books written about the construction of various forms and kinds of ships, and profound treatises are to be had upon every portion of marine architecture, with the exception of one very important point, *i. e.*, the operation of getting the completed ves-

sel into the water. This is no new problem, and we read that even Robinson Crusoe came to grief in his first experiment in boat-building because he had made no plans to get the hull upon which he had spent so much labour into the water where alone it could be of any service to him.

The recent meeting of the Institution of Mechanical Engineers at Plymouth naturally brought many subjects connected with ship-building into prominence, and among these one of the most interesting was the paper of Mr. H. R. Champness upon the launch of a battleship, as illustrated by the launch of H. M. S. "Ocean" at Devonport dockyard.

A ship is essentially a form of box girder, but it differs from a bridge girder in that it is intended to be supported in equilibrium throughout its entire length and is not constructed to resist the stresses which would come upon it when supported at a few points only. For this reason it is most important that the hull should be properly supported at many points during the course of construction, and especially necessary that the transition from the ways to the water should be effected without the production of serious strains.

All this work demands engineering skill of a high order, but it must be based upon practice and experience, since there are many elements for which accurate data are lacking and it has been only by numerous failures and mishaps that the present system of launching a ship has been successfully developed. Engineers without such experience have attempted to launch ships by novel methods, but in some instances, such as that of the Great Eastern, they have come to grief, while in others the methods used have not been repeated, but a return has been made to the general practice of shipbuilders.

The paper by Mr. Champness gives a detailed account of the construction of the cradles in which the ship is supported during the launch, and numerous illustrations show how much care and thought has been given to the distribution of the pressures and the provision for the strains. During the construction of the ship a careful record is kept of all the weights which are put on board as well as their distribution, and as the work progresses the supports are in-

creased in strength and number, so that when the launching date arrives the launching weight is known very closely. The "Ocean" was by no means unusual in size or weight, the launching weight being 7,110 tons, as compared with the 11,000 tons of the "Oceanic," but the mean pressure per square foot of cradle for the latter ship was only 2.35 tons as compared with 2.5 tons for the "Ocean." The pressure differs at various points during the launch, and as buoyancy is gained in launching, a point is reached when the fore end of the cradle is alone in connection with the groundways, and it is there that the local stress in launching is greatest.

In order to insure the absence of any alteration of form during the launch it is best to provide internal shoring, and in the case of the "Ocean" wooden shores were fitted within at points resting upon the cradle in order to distribute the pressure. All compartments below the calculated launching depth are completed and tested and the doors closed and fastened, and every inlet and discharge through the ship's bottom is tested and certified to be tightly closed, any neglect of such precautions being a possible source of disaster.

During the construction of the ship, after she is well set up, means are provided to ascertain how much the elasticity of the structure has permitted alterations of form, sight battens being fitted both longitudinally and athwartships from which measurements can be taken before and after launching in order to discover the extent to which any hogging or sagging may have occurred.

The cradle was prevented from moving, in the case of the "Ocean" by the use of two "dog shores" one on each side, these acting as struts between the cradle and the ground ways. At the moment of the launch these dog shores were knocked away by the drop of heavy weights, released by cutting the manila rope from which they were suspended. In order to provide for any possible delay in starting hydraulic rams were provided on each side to start the motion as well as one beneath the stern to ease the vessel off the groundways.

In the paper of Mr. Champness the method of lubricating the ways, and many other details of work connected with the launch-

ing of a ship are given, the whole forming, so far as the author is aware the first connected and detailed account of the principles and work involved in the launch of a large battleship.

The Durability of Water-Tube Boilers.

THE question of the durability of the tubes used in water-tube boilers is a matter of such importance that the paper by Mr. A. F. Yarrow before the Institution of Naval Architects giving details of his tests of tubes will be received by engineers with much satisfaction.

The experiments were made to determine the relative durability of tubes of mild steel and of nickel steel, the mild steel tubes being such as have hitherto generally been used in water-tube boilers, and the nickel steel tubes containing from 20 to 25 per cent. of nickel.

The causes of the deterioration of boiler tubes are given as (1) action of acids in the water, due to the presence of grease, (2) oxidation on the outside by the action of the furnace gases, and (3) deterioration on the inside by the action of superheated steam.

Mr. Yarrow endeavoured to repeat as nearly as possible the conditions which exist in actual practice, and by exposing both kinds of tubes to the same influence, to determine the relative resisting power of each.

The corrosion test was made by suspending weighed pieces of each kind of tubing in dilute hydrochloric acid for periods varying from 21 to 168 hours, the extent of the corrosion being determined by the loss of weight in each case. This test showed a remarkable advantage in favour of the nickel steel, the loss by corrosion of the mild steel tube being 16½ times what it was in the nickel-steel tube. Mr. Yarrow remarks that it may be contended that the relative corrosion of the two specimens when using dilute hydrochloric acid does not correspond with what it would be with such acids as are present in boilers under working conditions, but says, that it is not unreasonable to suppose that it may serve as a guide.

The second test was intended to show the action of gases and fire upon the exterior of the tubes. In this experiment two tubes

were placed in a small brick furnace arranged so that they would be heated under identically the same conditions. The extent of the corrosion by the action of the heat and gases was determined by the loss in weight after repeated heating and cooling, the scale being removed between each heating, and the tubes weighed to ascertain the rate of loss. After five such heatings, coolings, and scrapings the nickel steel tube was found to have lost about 27 per cent. of its weight, and the mild steel tube 76 per cent., thus showing that the nickel steel resisted fire corrosion 2.9 times better than the mild steel.

Since these tubes had no steam on the inside, a further series of tests were made at the instance of Sir John Durston, to determine the effect of superheated steam. In these tests the tubes were placed in a furnace side by side, and fed with steam at one end, the pressure of 60 pounds per square inch being maintained at the inlet and the steam allowed to escape slowly at the other end. This kept the tubes filled with highly superheated steam, and the corrosion from the steam within was added to that of the fire without. In this trial the loss of weight of the nickel-steel tube was much less than that of the mild steel, and after 10 hours the mild steel tube gave out and had to be replaced. A second mild-steel tube gave out before the nickel-steel tube began to leak, and the durability of the nickel-steel tube was recorded as 21 hours against a mean of 9 hours for the two mild-steel tubes.

Since the question of expansion and contraction has an important bearing upon the question of water-tube boiler construction, tests were made to ascertain the relative expansibility of the two materials. By raising the temperature to a dull red it was found that the nickel steel expanded the most, the relation being as 3 to 4, and hence it would be inadvisable to use both kinds of tube side by side, as leakage due to the unequal expansion would be likely to occur.

The general conclusions to be drawn from these experiments are so entirely favourable to the use of nickel steel that Mr. Yarrow expresses himself as convinced of its eminent superiority over mild steel for use in water-tube boilers. As regards acid

corrosion there would be a vastly longer life for the nickel steel tubes than for the mild steel ones, while as regards deterioration from the action of heated gases or steam the former has at least twice the durability of the latter. So far as the question of cost is concerned it is quite possible that the longer life of the nickel steel, together with the saving of labour in replacing tubes, may make it less expensive in the long run than the apparently cheaper material.

Ice Breaking Steamboats.

MENTION has already been made in these columns of the powerful ice breaking boats which have recently been constructed for use in Russian waters, and at the recent meeting of the Institution of Naval Architects an interesting paper upon the construction of these very effective vessels was read by Mr. H. F. Swan.

For a long time the ports on the Baltic have been endeavouring to obtain some relief from the obstruction which ice offers to navigation, and various forms of ice breakers have been constructed, but until recently such boats have not been very effective in keeping the harbours open.

Up to three or four years ago the principle upon which these boats operated was that of climbing up on the ice and breaking it down by sheer weight. For this purpose the forefoot was cut away from a point on the stem above the water line in a slanting direction, striking the keel about one-fourth of the vessel's length from the bow. A boat of this form, when provided with powerful engines, could be forced up on to the sheet of ice, and if the latter was not too thick it would be broken down by the weight of the boat and a channel thus forced through.

Experience with ferry boats provided with a propeller at each end, however, showed that the disturbance of the water by the forward propeller has a very powerful disruptive influence on the ice. In 1893 this principle was embodied in the American ice breaker the *Marie*, and since then several very effective boats have been constructed on this principle for use in Russian ports. Of these modern boats the *Ermack* is the most celebrated as well as the most powerful. This most successful ice

breaker is of 8,000 tons displacement and 10,000 horse power, and is provided with three propellers aft and one forward. Both bow and stern are provided with an exceptional amount of overhang and the sides are inclined outward at a considerable angle from the vertical to prevent crushing when nipped in the ice. Internally the framing is of great strength, there being 48 compartments, while externally the surface is made as smooth as possible, both butts and seams being flush-plated. The vessel is also fitted with pumps of great power, connected with trimming tanks at the bow and stern and on the sides, so that if the boat gets caught in the ice the horizontal plane can be varied in any sense desired, thus assisting in manœuvring.

"Experience with the *Ermack* has shown that she has broken composed ice of 8 ft. 3 in. in thickness, and she has gone through field ice of about 40 in. thick with 6 in. of snow upon it, at a speed of $2\frac{1}{2}$ to 3 knots; moreover, she has been driven at a speed of about 10 knots through clear ice of 24 in. thickness, whilst ice under 18 in. has little effect upon her. It was found that snow has a wonderfully great influence upon an ice breaker, much more so than a similar thickness of solid ice."

The commercial value of such a vessel is shown by the fact that immediately upon her arrival the *Ermack* liberated thirty-three steamers from the harbour of Reval, after which she proceeded to Cronstadt and St. Petersburg and opened the port several weeks before it would otherwise have been possible, and enabled forty vessels to enter.

It has been suggested that vessels of this type might be valuable aids in connection with Arctic explorations, but it must be remembered that the conditions are not altogether similar. In the Baltic the ice is formed gradually at moderate temperatures, and the same result could not be looked for in the case of service in the Arctic regions, where the ice is of a much harder and more brittle nature.

Mr. Swan's paper gives some interesting information about the powerful train ferry boats constructed for use on the Volga and on Lake Baikal, and gives full credit to Admiral Makaroff, of the Imperial Russian Navy for the initiative in connection with the Russian ice breakers.

Atmospheric Railways.

THE general introduction of pneumatic dispatch tubes for conveying mail to and from sub-station post offices, as well as small packages in commercial establishments, renders the historical account of the early atmospheric railways presented by Sir Frederick Bramwell at the meeting of the Institution of Mechanical Engineers a matter of much interest.

At one time it was thought that atmospheric pressure was likely to become an important means of propulsion for railways, and the experiment, as related by Sir Frederick, was carried out upon a large scale under the supervision of an engineer of the skill and ability of the late Isambard Brunel.

The principle of the South Devon Railway, which formed the main subject of Sir Frederick Bramwell's paper, was devised by Clegg and Samuda, and involved the use of a vacuum pipe beneath the track between the rails, the pipe being fitted with a piston impelled forward by atmospheric pressure when the air was exhausted from the tube. An arm extended up from the piston and was attached to the leading carriage of the train and thus the entire train was drawn along. It will be seen that this arrangement involved a slot along the entire length of the tube, and the main problem of the system was the method of keeping the tube air-tight and at the same time permitting the arm to reach out and be connected with the train. This part of the device was the much-talked-of "valve," and really consisted of a strip of leather, like a belt, which lay along the entire top of the tube, there being a flat seat there constructed for it, the vacuum in the tube causing this belt to be held down tight by atmospheric pressure. The arm which came up through the slot was attached to the piston on the side away from the exhausted portion of the tube, and was provided with a yoke through which the belt-valve was lifted up, rollers being connected in front and behind the arm in such a manner as to lift and close the valve before and after the passage of the arm.

It will readily be imagined that such a device was not easy to keep tight, especially with such mechanical appliances as were available fifty years ago, and an interesting

portion of Sir Frederick's narrative relates to the difficulties which were encountered.

When the apparatus worked all right the railway was very pleasant, there being no dust, smoke, nor cinders, but when the valve did not close air-tight the engine pumped on in vain and the train had to wait helpless at the station.

The road, from Exeter to Newton, was about twenty miles long divided into sections of about three miles in length, each section being provided with its own pumping station, and the system was operated more or less completely from 1846 to 1848.

As might be supposed, the efficiency of such a system was not high, large losses from leakage being inevitable, and according to Brunel it required 865 horse-power to perform work represented by 300 horse-power, an efficiency of about 35 per cent.

Although this interesting experiment has been obsolete for more than fifty years it is interesting to note how in many ways it was an anticipation of some modern successful systems. It is very closely represented to-day by the cable tramway systems which are in successful use in many places, the real difference being mainly in the fact that a cable of wire rope does the work which Brunel attempted to do with a cable of air. The conduit has its slot, and the arm from the car extends down into the tube, but with the cable tramway no valve

is required, and the engine at the power station has its direct connection to the train without risk of leakage. In most respects the cable has all the advantages which Brunel expected to gain by the atmospheric tube. The smoke, smell, and noise of the locomotive are all absent, and all the advantages of stationary power stations are attained, while the control of the car, especially for the frequent stoppings and startings required by local traffic, is much better.

Still more nearly resembling the atmospheric railway in some respects is the modern electric tramway, especially when the underground conduit system is used. Here all the advantages which Brunel hoped to realise are attained with none of the difficulties against which he contended. Although the electric current flows through the conductors it is even less apparent than the air pressure of the older system, while the absence of reciprocating parts and the general smoothness of motion and all the other advantages so well described by Sir Frederick Bramwell are completely attained.

In these respects at least the account of the old atmospheric railway certainly forms a most interesting bit of mechanical history, showing how many desirable features were anticipated only to be realised in a different manner fifty years later.

REVIEW ^{OF} THE CONTINENTAL PRESS

Electrical Conductivity at High Temperatures.

SINCE the public announcement and demonstration of the Nernst incandescent electric light there has been much interest manifested in the behaviour of various materials as regards their conductivity at elevated temperatures. A paper upon this subject has been read by Professor Nernst before the recent convention of the German Electrochemical Association, and published in the *Zeitschrift für Elektrochemie*, giving some valuable information in this connection.

Within very wide limits the conductivity of metallic substances is almost independent of temperature, although at very low temperatures the conductivity is greatly increased and at very high ones much diminished. For electrolytic conductivity the opposite effect appears, and at very low temperatures, such as the boiling point of liquid air electrolysis no longer takes place, while on the contrary fused salts are especially good electrolytes.

That electrolytic action may also take place in solids is now generally admitted, and the theoretical discussions of van't Hoff go far toward rendering such action intelligible. The experiments of Professor Nernst himself show, in connection with the use of solid electrolytes as incandescent illuminating bodies, that the increase in conductivity at high temperatures is far greater than has hitherto been believed.

Professor Nernst's experiments were made by pressing the pulverised material into small rods with platinum connections at the ends, and determining their electrical resistance while in a small electrical furnace formed of a platinum spiral enclosed in asbestos. The temperatures were determined at the same time as the resistance, the platinum-rhodium pyrometer of Heraeus being employed.

These experiments showed that pure oxides showed a very slight increase in conductivity, even when raised to incandescence, the conductivity remaining very low at all times, while on the contrary mixed

substances in some cases showed a very high increase in conductivity, almost as great as that of fused electrolytes. This action is especially apparent with mixtures of oxides of magnesium, silicon, zirconium, etc.

Fearing that the incandescent medium might be rapidly decomposed by electrolysis, Professor Nernst at first used only an alternating current, but his later experiments have been made with continuous currents. In the course of these experiments it appeared that a rod composed of mixed oxides could be maintained at incandescence for hundreds of hours by means of a continuous current without showing evidence of destructive decomposition. At first this action might be supposed to indicate a conductivity similar to that of metallic substances, but further investigations show that such is not the case. When some of the oxides are colored, as in the case of iron or cerium, it is found that these gradually travel toward the cathode, and if there is much magnesia present in a pencil it is found that the cathode end becomes the larger. During incandescence it is to be observed that the cathode is always much darker than the anode, which may be explained by the tendency to liberate metallic particles at the cathode and rendering that portion a better conductor, while the evolution of oxygen at the anode increases the resistance there.

Apart from the uses of the device for lighting, it appears that other practical applications may be made. Professor Nernst calls attention to the fact of the remarkable constancy of the resistance of a given pencil for given temperatures, and suggests that by the use of electrodes of iridium in connection with a pencil of mixed oxides a reliable and convenient pyrometer for high temperatures may be constructed.

In connection with the discussion upon the paper of Professor Nernst it was suggested that the migration of the coloring matter towards the cathode might indicate a method of removing objectionable color-

ing substances from precious stones. If it were possible to decolorize black diamonds by this process a field of enormous possibilities would be opened, and with other gems important transformations might be effected. While distinctly stating that this had not yet been successfully accomplished, Professor Nernst conceded it to be a possibility, although in the case of the diamond the very low electrolytic conductivity of fixed carbon offered a great difficulty to the practical realisation of the important result.

Railway Terminals in Paris.

AMONG the many changes and improvements in Paris which have been caused by the approaching exposition some of the most important are naturally those intended to assist in providing increased transportation facilities. Nearly every railway possessing a terminal in Paris has been expanding the accommodations to the utmost, while extensions of main lines, and the acquisition of suburban connections have been carried on with the one end in view of providing for the expected increase in travel.

Naturally the greatest of these works is that of the extension of the Orleans Railway from the Place Valhubert to the Quai d'Orsay, and the construction of the magnificent new station on the site of the old Cour des Comptes. This important work has already been described at length by Professor Boyer in the April issue of this magazine, but since that time important progress on the work has been made and described in recent issues of *Le Génie Civil*, *La Revue Technique* and other technical journals. At the present time the work is well advanced on the subway, which is about two and one-half miles long, and the photographs recently issued show the construction to be of a character which in no way detracts from the appearance of the quay or river front.

The question of motive power for use on this section of the road has been under consideration for some time, and it is evident that ordinary steam locomotives are unsuitable for the conditions. Besides the stretches of open subway and of intermediate tunnelling, in both of which the smoke and gases from locomotives would be most objectionable, the entire trackway of the

terminal station is on the lower level, with the waiting rooms, hotel and offices above. To have this lower floor filled with smoke and gas, rising through the floors above to poison the air, would be most objectionable. After a consideration of the possibilities of fireless locomotives, compressed air, and similar substitutes, a commission was sent to the United States to examine into the subject of electric traction there, and as a result it has been decided to use electric locomotives entirely to haul the trains from the Gare d'Austerlitz to the new station. The old terminal will be preserved intact, and used for as much of the traffic as possible, while the bulk of the passenger travel will be delivered into the heart of Paris by means of the new subway without any of the inconvenience ordinarily experienced from smoke, dust or gas.

The Eastern Railway of France will retain its terminal on the rue de Strasbourg, but is making extensive enlargements. An entire block of houses has been acquired, and two small streets which divided the property from the old station have been vacated, and the whole is being taken into the roofed area of the station. This will permit the removal of the inward-bound baggage department and the covered court for arriving passengers to be thrown into the space for the train shed, while at the same time greatly improved quarters for the arriving travellers will be provided in the new portion. An electric transfer table is also to be installed in order to enable trains to be made up with greater ease and dispatch than is now possible by the use of turn-tables. A very full account of these improvements is given in *La Revue Technique*, with plans of the old and new stations, and elevations of the train sheds and court-yard roof.

The Western Railway of France has increased its importance and local capacity by the acquisition of three suburban lines. The first of these is that of the ceinture or belt railway which skirts about the fortifications, and from which subways are being constructed giving direct access to the Champ-de-Mars and the grounds of the exposition. The other lines are those from Issy to Viroflay, and from Plaisir-Grignon to Epône, which will not only control their present local traffic, but will also permit the

trains from Normandy and Brittany to be directed at will to any one of the three stations of St. Lazare, Montparnasse, or the Invalides.

A full account of the work upon these lines, with sections of the necessary subways, is given in the *Revue Générale des Chemins de Fer*, together with much interesting information concerning the application of electric traction which is to be made of these lines.

The whole subject of electric traction on main-line railways is being given serious consideration in France, and apart from these local and subway installations which are being made within the city of Paris some extensive experiments with electric locomotives have been conducted on the Paris-Lyons-Mediterranean Railway. A recent issue of *Le Génie Civil* describes some of these electric locomotives of 45 tons weight, capable of hauling trains of 100 to 150 tons weight at speeds of 60 to 75 miles an hour. These locomotives are operated by accumulators, which are charged from generating stations situated on the Swiss frontier and in Haute-Savoie, at the foot of Mont Blanc, where abundant water power is available. The weight of the accumulators, so far from being objectionable, is in this case of service in securing the necessary adhesion, and the trials which have been thus far made have been most satisfactory.

Water Hammer in Steam Pipes.

THE question of the strength of pipes, valves and fittings is one which has been discussed in various quarters of late, and serious accidents have called attention to the importance of providing ample strength in all steam connections. There should be no difficulty in providing for all the regular working stresses upon pipe connections, but in practice it is found that there are shocks and so-called hammer-blows, the full force of which it is difficult to measure or estimate.

The results of recent investigations upon this subject by M. Walckenaer have recently been published in the *Annales des Ponts et Chaussées*, and the matter is of sufficient interest to bear review and discussion.

The conditions which exist in a pipe containing steam and water of condensation

are peculiar, and not always fully understood. When a pipe contains air or a similar gas, there is an elastic cushion formed which, in case of a sudden arrest of flow of water, absorbs the shock, and acts like a spring to prevent any serious hammer-blow. When, however, the closed end of the pipe contains steam, the projection into it of a volume of water may cause a sudden condensation, entirely removing any elastic cushion, and permitting the occurrence of a violent shock.

It is hardly practicable to compute the magnitude of the blows which are thus produced, but it is well known that they may cause serious ruptures in connections amply strong for all ordinary working pressures. M. Walckenaer cites certain experiments made in the German navy, in which pressure gauges placed upon the pipe showed sudden impact pressures ranging from 500 to 2,000 pounds per square inch. A number of examples are cited at length, giving details of accidents all of which show a strong family likeness, stop-valves between boilers being violently ruptured when communication was opened too suddenly between connections of marked difference in pressure. There appears to be little or no doubt that in most if not all of these cases the hammer blow which caused the rupture far exceeded any normal working pressure.

Such accidents may generally be avoided by using care in making such communication, as the valves should be opened so gradually as to prevent a sudden rush of water and steam together. In many instances, however, it is not practicable to avoid shock. The connections between engines and boilers are sometimes so arranged that very serious water-hammer impacts may be produced. M. Walckenaer cites cases in which the connections were such as are frequently found in practice.

In all of the accidents described by Mr. Walckenaer the connections were so arranged that an accumulation of water of condensation in the pipes could occur. In one instance the ruptured valve formed a portion of the connection to a boiler which was out of use and cold while others in the same battery were in service. The opening of a valve permitting steam from a live boiler to flow into the general steam main caused a violent water hammer back

against the valve on the cold boiler, causing rupture of the valve body with serious scalding of the attendant. This system of connecting a number of boilers in battery to one steam main is a very general practice, and while it possesses numerous advantages it has the defect of providing space for the collection of water at various points. Steam traps for the drainage of all places of accumulation of water should be provided, and such traps ought to be of liberal capacity, in order that the drainage may be prompt and effective. Even when a system of piping is altogether free from water at the time of starting the rapid condensation of steam which at first occurs may provide sufficient water to cause violent pounding, and this can only be prevented by a gradual warming up of the whole system, the admission of steam being so gradual that the traps can take care of the water of condensation as rapidly as it is produced; the full volume of steam being admitted only after the pipes have become hot.

The Düsseldorf-Krefeld Tramway.

At the time of the account of the construction of the bridge across the Rhine at Düsseldorf mention was made in these columns of the fact that the company undertaking the bridge construction had also obtained a concession for the construction of an electric tramway to Krefeld, including the right of way over the bridge into the city of Düsseldorf. This tramway is now completed and in operation, and from a paper read before the *Verband Deutscher Elektrotechniker* and published in a recent issue of the *Elektrotechnische Zeitschrift*, some of the more important features may be taken.

Krefeld, an important manufacturing town, is on the opposite side of the Rhine from Düsseldorf, and the latter city has until now had no convenient communication with it, while there had for some time been a steam railway from Cologne to Krefeld by way of Neuss. When the new Rhine bridge was completed it was seen that the electric tramway which had been planned between Düsseldorf and Krefeld would have to compete in speed with the steam road if the traffic with Cologne was to be met. We have therefore in this case a direct competition between steam and elec-

tricity, which, if not on main-line railways, is at least operating under somewhat similar conditions.

This competition involved for the electric railway, higher speed than would otherwise have been the case, and hence it was found necessary to avoid highways and conduct the road over an isolated track, passing in close proximity to the various villages on the way but not passing directly through them. The total length of the railway is about 14 miles, a little over 10 miles being in the open stretch between the two cities, and, possibly, with a view to further extensions, the road-bed construction and general equipment, other than electrical, has been made to correspond to the standard requirements of the German State Railways.

For the electrical equipment, which has been constructed by Messrs. Siemens & Halske, the overhead trolley system has been adopted, with the exception of a short section in the central portion of Düsseldorf, where accumulator traction was at first proposed but where it has finally been decided to employ the underground trolley.

In order to keep the cost of construction down it was decided to use as high a pressure as practicable, 600 volts being adopted, and as the road is isolated and protected it would have been possible to use higher pressures had it not been thought desirable to arrange for possible future connections with the local tramway systems in the two terminal cities. In order to provide against possible interruption through breakage, two trolley wires have been stretched, the Siemens sliding collector being used instead of the trolley-wheel, and the return made through the rails as usual. The motor cars are with bogie trucks, as there are a number of sharp curves on the line, there being a 40 h. p. motor on each axle of the motor truck, with direct connection, no gearing being used. Powerful motor cars were planned because the work partakes much of the nature of regular railway traffic. There are passenger trailers to be hauled, and market produce cars as well, while covered goods wagons of the regular German type are to be attached whenever general merchandise is to be transported. The road is thus a regular light railway for general traffic with passenger motor cars instead of

locomotives, and is operated in competition with a steam road for general business.

At the terminals, and for the short distance local business a few miles out, there is a regular service at short intervals, and the speed is there limited to the conditions of operation, but out on the main line, over which half-hourly trains are run, the speed is increased to 25 to 35 miles an hour.

This railway, which occupies a middle position between the steam road and the local tramway, has been in successful operation since the beginning of the year, and has shown a continually increasing traffic, and while the conditions which led to it were in themselves exceptional, yet in operation it may show that for such intermediate lines electricity possesses advantages which will lead to its extended introduction for general traffic.

A Study of Power Gas.

THE increasing interest which has appeared of late in the use of internal combustion motors has led to a corresponding attention to the improvement in apparatus for generating gas which should be available for use in motors and at the same time less costly of production than illuminating gas.

Prominent in this branch of engineering the name of M. Lencauchez has been associated, and the presentation of a long paper by him before the *Société des Ingénieurs Civils de France* upon gases for motive power is worthy of especial notice, particularly as it drew forth an animated discussion from others engaged in similar lines of work.

M. Lencauchez gives a complete classification of the various kinds of combustible gas which can be commercially manufactured, including the gas distilled from bituminous coal, and the gases which may be distilled from lignite, peat, or wood, also water-gas made with anthracite, or with wood, as well as the various kinds of producer gas.

The original work of M. Lencauchez is mainly known in connection with the gas producer which bears his name, and which has been extensively employed for the generation of a cheap, clean gas for use in internal combustion motors. Recently there has been much attention given to the

process of M. Riché, which produces from wood a much richer gas than can be made in the ordinary fuel-gas producer, besides rendering a valuable by-product of charcoal, and M. Lencauchez devotes the greater portion of his paper to a comparison of the two systems. Apart from the interest which may be attached to the methods directly discussed in the paper, the whole subject of fuel and power gas is becoming one of general importance and the general information which is given in the discussion therefore raises the paper from its special position into one of wider value and application.

The cost of distilling bituminous coal prevents its application and a method of producing power gas, this process being profitable only for the generation of illuminating gas, or for power in cases in which convenience outweighs cost. Gas distilled from lignite, peat, or wood is so little used as to demand no further attention, and M. Lencauchez passes on to water gas and producer gas.

Water gas made from coal has not been found economical as a source of power, but when enriched by hydrocarbons it has found a wide application for illuminating purposes. When wood, however, is distilled in such a manner that the water contained in it, as well as the tarry liquids, are caused to pass through the incandescent carbon, a form of water-gas of high calorific power is produced which is claimed to be well adapted for power generation. It is this process which bears the name of M. Riché, and which bids fair to become a commercial rival, in certain localities at least, to producer gas as a source of power. Producer gas, as is well known, may be generated simply by burning coal, coke, or coal-slack, with a supply of air insufficient to permit complete combustion, the result being a gas consisting mainly of carbonic oxide and nitrogen, which while of a low calorific power is also of very low cost. It is to this class that the discharge gas from blast furnaces belongs, concerning the application of which so much has of late been said.

In comparing these different kinds of gas, so far as their commercial efficiency in power generation is concerned, it is necessary to take into account not only the calorific power, on which the value directly depends.

but also the cost of generation, and hence it follows that the richest gases may not be the most economical.

In the case of producer gas, a low grade of fuel may be employed, although in most instances difficulties from caking and clogging are experienced with low-grade fuels, but the process necessarily involves the loss of the heat produced by the combustion of that portion of the fuel used in gasifying the remainder, so that about 30 per cent. of the heat in the fuel is used in the producer. Another feature which must be considered in connection with the use of producer gas in gas engines is the larger size of engine necessary for the production of a given power, as compared with the use of richer gas.

The average calorific power of the various kinds of gas in British thermal units per cubic foot is as follows:

Blast furnace gas	100 B. T. U.
Producer gas, from coke.	135 B. T. U.
Water gas, from coke...	300 B. T. U.
Wood gas, Riché process	340 B. T. U.
Illuminating gas, distilled	
from gas coal	600 B. T. U.

Leaving out of consideration the illuminating gas, and the water gas, we have for comparison the producer gas and the Riché wood gas, the blast furnace gas being practically a poor grade of producer gas, the utilisation of which depends rather upon problems of purification from dust than from any peculiarity of composition.

M. Lencauchez claims that the Riché gas costs more than it is worth, and calls attention to several points. The retorts require to be heated by fire from without, and the coal consumed to effect the distillation must be charged against the value of the gas produced. The steam which acts to produce the water-gas, is made in the retort itself, which is by no means so efficient a place to generate it as would be a separate boiler. It is claimed also that the charcoal, the value of which is to offset the cost of the gas, is of inferior quality, and of small marketable value.

In the body of the original paper of M. Lencauchez, as well as in the discussions by M. Riché and MM. Manaut and Roman, the details of actual cost and effective power obtained by the use of various kinds of power gas are fully worked out. These

computations are too voluminous to be given here but the conclusions of M. Lencauchez are as follows:

Francs.

Cost of 1 h. p. hour using Riché	
gas	0.03036
Cost of 1 h. p. hour using steam	
engine, at 1 kg. coal per h.	
p. h.....	0.02
Cost of 1 h. p. h. producer gas	
from Anzin anthracite....	0.0163

Taking these figures to be correct, there seems to be little probability that the Riché gas will ever come into extensive use.

Electric Works in Germany.

IN the *Elektrotechnische Zeitschrift* is given the usual annual report of the progress of electric generating stations in Germany for the year, showing the growth which has been made in this important industry, together with some interesting general statistics. The year is closed on the first day of March, after which some time is required for compilation and arrangement, and the full manner in which the results are arranged renders it possible to make some interesting studies.

The work of the year from March 1, 1898 to March 1, 1899 shows great and significant progress. In many places the old works have been found insufficient, and new plants have been constructed, while in others installations have been made where none existed before. The continuous current still hold its place in general favour, more than 80 per cent. of the new plants being of this type. The total number of new installations for 1898-1899 is 114, bringing the grand total of electric generating stations, not including isolated plants, up to 489, as against 375 for the preceding twelve months. In addition to these there are 123 works in course of construction and 15 others about to be built, making 504 works which will be in operation before the close of the current year. Of these establishments 486 have been constructed during the past ten years. The oldest electrical plant in Germany is the Markgrafstrasse station in Berlin, which was built in 1885.

A noticeable feature of many of the modern works is the general use of accumulators for the purpose of equalising the

load. More than 90 per cent. of the continuous-current stations, or nearly 75 per cent. of the whole number, are equipped with storage batteries, these averaging in capacity about 27 per cent. of the generating capacity of the stations.

There has not been a marked increase in the number of stations using alternating or polyphase currents, but the capacity of those already installed has been nearly doubled, while the entire output of all the stations in Germany has been increased by about 50 per cent. over that of last year.

In regard to motive power, steam still holds by far the first place, about 77 per cent. of the whole electrical output being developed from steam power, while 10 per cent. is generated from water power. This proportion is naturally one which is largely governed by geographical and physical considerations, and the proportion would be very different for a mountainous country like Switzerland, and judging from the interest which is at present being taken in this branch of the subject we may expect to find a rapid development of hydraulically generated electrical energy in Italy before very long.

There is, however, in Germany a number of stations employing a mixed source of power, both steam and water power being installed, the former to be used as a reserve in case of failure of the latter. These mixed stations form about 12 per cent. of the whole, the small remaining portion being driven by gas and petroleum motors. The total capacity of the plants at present in operation in the German empire is about 145,000 kilowatts, representing about 200,000 h. p. of mechanical energy.

A Novel Canal Lift.

THE interest which is at present shown in Germany and central Europe generally in the question of internal waterways has caused attention to be given to various details of canal construction, among which is the problem of overcoming differences in level. The delay caused by locks, as well as the limited range of action possible by their use, has caused various plans to be made in order to render it possible to raise and lower the boats through greater vertical distances with less loss of time. Among such devices the hydraulic lifts used at Les Fon-

tinettes in France and La Louvière in Belgium are well known, and the pontoon lift at Henrichsburg, in Germany, is a later device of similar nature.

Several of the plans which have been offered in connection with the proposed canal extensions in Germany involve the use of inclined planes, the boat to be floated into a tank of which the end is then closed and the whole hauled upon suitable tracks up the incline, where the tank is opened and the boat floated out.

A curious and ingenious modification of this inclined plane idea has been devised by Professor Czischek in connection with Herr F. Tentschert, and in a paper by the former in the *Zeitschrift des Oesterr-Ingenieur und Architekten-Vereines* an account of the new method is given.

The peculiarity of the new plan consists in the tank in which the canal boat is conveyed up or down the plane, this being made in the form of a hollow cylinder, open at the ends, and large enough to contain not only the boat, but also a sufficient body of water to enable the latter to float in it. The ends of the cylindrical tank are fitted with heads reducing the circular opening to a smaller diameter than that of the cylinder, a cylinder of 16 metres in internal diameter having end openings of 9.5 metres diameter. When such a cylinder is immersed to its axis in water a canal boat can be floated in, while even when the cylinder is entirely out of the canal there will be enough water retained in it to float the boat.

The boat thus being inside the cylinder, the latter can be rolled up or down an inclined plane in the same manner as a barrel is now handled, the boat floating in the water within and always maintaining its level position. An inclined plane is constructed from the lower canal level to the upper one, the plane being at right angles to the direction of the canal, and so formed that the cylindrical tank can be rolled up to a point slightly higher than the water level of the upper canal and then over the hill down into the water. It will be seen that this device entirely eliminates the necessity of any water-tight gates at the end of the tank, no gates of any kind being needed at all. The boat is simply floated into the open end of the cylinder, and, by means of

rope tackle passing around the exterior it is then slowly rolled up, the excess of water running out of the ends, but enough being retained to float the boat. At the upper level the cylinder rolls up over the hump and down into the water and the boat is floated out, while the reverse operation is performed in lowering.

There are manifest problems to be encountered in the construction of a drum 16 metres in diameter and 70 metres long, and the plans in Professor Czischek's communication show it constructed with twelve longitudinal trussed ribs of two metres depth, thus bringing up the outside diameter to 20 metres, there being hoops at intervals around the ribs, forming tires which roll upon tracks provided for the purpose.

Experiments on the Strength of Glass.

THE extensive use of glass in construction renders definite information about its resistance under various conditions of stress desirable, but with the exception of the ultimate strength under direct compression, but little has been known about the subject until recently.

A series of experiments upon the resistance of glass to tension and to flexure has recently been made by M. Grenet under the auspices of the *Société d'Encouragement pour l'Industrie Nationale*, the details and results being published in the Bulletin of the society. The glass tested was of two varieties, manufactured by the well known works at Saint-Gobain, one being the grade known as No. 4, and the other the so-called "cathedral glass," and there being but little difference between the two shown by chemical analysis.

In the flexure tests the specimen was placed as a beam, supported on knife edges and with the load applied in the middle, the weight being a bucket suspended from a cross bar and arranged so that water dropped regularly into it from a separate vessel. The load could thus be applied at a uniform rate without the possibility of shock, and the rate of application kept under perfect control. By applying the usual formula for rectangular beams loaded in the center, the tensile strength per unit of cross section was determined.

The most interesting feature which was developed by these tests was the marked effect produced by variations in the rapidity with which the load was applied. It is well-known that for nearly all materials a rapidly applied load will show an apparent resistance much greater than appears when the stress is applied more slowly, but in the case of these tests upon glass the effect is especially marked. Thus the tensile strength of a number of specimens averaged 6,000 to 7,000 pounds per square inch when the load was applied at a rate which caused the rupture to occur in 15 to 20 minutes, while when the duration of application was increased about three times, so that rupture occurred in about 45 minutes, the strength ranged between 5,000 and 6,000 pounds per square inch. When the water dropping device was arranged for very slow loading, and the breaking load was attained in 10 to 12 hours there was a marked diminution in strength, the resistance per square inch being only about 4,200 pounds.

In order to show the reverse effect some tests were made with loads applied very rapidly, and the effect was most marked, the mean of three trials giving an apparent strength of 10,000 pounds per square inch.

A number of flexure tests were also made by M. Grenet upon glass rods, and these showed the same general results as regards the effect of rapidity of application of load. The actual strength of the rods, however, was higher than that of the plates, which was probably due to the difference in the method of manufacture. Thus when the rupture was produced in about 15 minutes, the strength was nearly 11,000 pounds per square inch, while when the time was extended to 45 minutes the resistance fell to about 9,000 pounds, and for the 12 hour tests the breaking strength was but 5,700 pounds. In order to carry this feature of the tests to an extreme limit M. Grenet suspended various weights to rods and allowed them to remain for a number of days. The result showed that for loads of 3,000 to 3,500 pounds per square inch no rupture occurred even after the expiration of three months, but when the loading was increased to about 4,000 pounds rupture took place in one or two days.

REVIEW OF THE AMERICAN PRESS

The Action of Engine Gases on Bridges.

DURING the recent visit of the American Society of Civil Engineers to the new subway of the Philadelphia and Reading Railway Company, in Philadelphia, attention was drawn to the number of steel girder bridges by which streets are carried across the depressed line of the railway. In connection with the question which was then raised as to the probable action of the gases from the locomotives upon these structures, *Engineering News* discusses the whole subject in an editorial which is well worth reviewing.

The question is really one of much importance, and also one which has by no means received the attention which it demands.

"The corrosive action of locomotive gases is now a matter familiar to every engineer; it is just as certain that these gases will rapidly corrode iron and steel surfaces as it is that sulphuric acid will do it. Is it exactly creditable, then, to the engineering profession to go on putting up expensive steel structures just where they will be exposed to these corrosive agents, and providing them with no better protection than a coat of paint? How much risk is involved in the reduction of sections due to the gradual corrosion? How much does this unknown and unwatched process decrease the factor of safety from year to year?"

The question is not a new one, but it is one of increasing importance, and hence the agitation is most opportune.

"The work of abolishing grade crossings of railways and highways is extending year by year. Every year sees a great number of additions to the list of overhead bridges crossing railway lines. Most of this work is carried out in the most thorough and substantial manner. The public and the corporations which are paying for the work consider and expect it to be permanent, and the engineer ought to spare no pains to insure its permanence. He is not doing this when he calmly puts all his expensive steel-

floor system and the bottom chords of girders or trusses into a bath of sulphuric acid and leaves them to certain and rapid destruction."

While this state of affairs certainly does not appear creditable to the engineer, yet there is one reason why it has not earlier been given the attention which it properly demands. That reason is the blind confidence which has been placed in the efficacy of protective paints. The manufacturers of various paints have affirmed that their products were certain protections against the action of corrosive gases, and the engineers, with a confidence worthy of a faith cure victim have proceeded to put painted iron-work where no paint has ever stood or ever will. "As the paint gradually disappeared, some conscientious engineers have repainted and have gone on repainting until the accumulation of coat after coat became too evidently worthless to continue the process longer. Others have resigned themselves to the inevitable and let the rusting go on without attempt at interference."

There are several reasons why no protective paint can be relied upon under such circumstances. In the first place it is practically impossible to insure a perfect continuity of the painted surface, no matter how great care be given to the application of the paint. Even the Bower-Barff process, by which the surface of the metal itself is converted into the rustless and highly resistant magnetic oxide, cannot be so performed as to insure the absence of pin-holes, even when the cleansing action of the sand blast is used to prepare the surface. Beside this we have in the case of the railway crossing the action of the cinder, ash, and sparks discharged by the locomotives, to cut through any protective paint, however good, and expose the metal to the action of the corrosive gases.

It will not do for the engineer to plead that he has done the best in his power when he has placed a steel or iron girder across a railway track and given it a few coats of a commercial protective paint. There are

other and better constructions and the competent engineer knows them all. The brick or masonry arch is by no means obsolete, and indeed there has been of late in many quarters a decided tendency to revive this ancient, honorable, and wholly valuable form of construction. The arch has lived a long and useful life and is by no means yet dead. Indeed it has recently taken a new and vigorous lease of life in connection with the so-called "reinforced concrete" construction, and there is every reason to believe that flat arches constructed on the Mornier or Melan principle, with steel structure entirely imbedded in concrete, would serve most effectively for railway crossings where contact with sulphurous gases is inevitable.

The opinion held by many from the first, is being confirmed by growing experience, that steel or iron structural work, wholly imbedded in concrete, is altogether free from deterioration by corrosion. The iron work of the old Palais d'Industrie, which stood on the Champs Elysées from 1862 until 1898, revealed no evidence of corrosion of its imbedded iron work when it was demolished, and other examples in the United States have confirmed this experience. The whole question is one of oversight and misplaced confidence, and while much reckless work has already been done in placing important structures where they are certain to be destroyed by corrosion in a few years it is not too late to take warning for the future, and to avoid such negligence in the future.

An Automobile Association.

WITH the increasing use of motor vehicles has come a realization of the opposition which must be expected in some quarters to the innovation. The bicycle rider had to fight his right of way, so to speak, not so very many years ago, and the owner or driver of the motor vehicle finds himself in much the same position to-day. It is apparent that such opposition can be only temporary, but it will be overcome much sooner by concerted action than in any other manner, and with this end in view the *Electrical Review* proposes the formation of a national automobile association to accomplish in the United States what the Automobile Club has done in France.

"To-day the self-propelled vehicle—whether electromobile or oil driven, or other machine for country use—stands in the same position that the electric light and the electric street railway occupied in 1884 and 1887, respectively; its coming is opportune and its future big with promise, but its novelty and unfamiliarity work to its disadvantage."

Instead of waiting for the slower influence of public opinion it is suggested that a strong association, consisting not only of owners and users, but also of makers and inventors, be formed to insist upon the rights of such vehicles to the roads and parks under the same conditions as already exist for other vehicles, and that unfair and prejudiced discrimination be handled in the same manner as any other form of injustice.

"There seems to have been recently a wave of municipal opposition to automobiles, and the commissions in charge of parks in several large cities have been compelled to suffer the discipline of the courts before they would see reason. There are many interests which are in apparent conflict with those of automobilists, and it is not to be doubted that certain classes of horsemen will endeavor to assail both the popularity and the development of the automobile in every possible way. There is need, therefore, both for legislation and wisest municipal regulation, and also for missionary work to be done with the press and among the general public. To the large majority of the latter the automobile is still a curiosity. To familiarize them with the machine, to teach them the immense and wide-reaching advantages that will follow its general use, to popularize the automobile so as to create among the masses of people a demand for such vehicles, resulting naturally in cheapening and bettering their construction, will be a few among the many good works which the association that has been outlined can perform.

"All these things are now being undertaken by various users and makers of automobiles, and by small societies of only local extent in various parts of the United States and Canada. If the effort that is thus diffused can be properly concentrated, the effectiveness of the work done will be

vastly enhanced, and results will be obtained with far less trouble and expense. The concentration of effort will give to a strong general organization the ability to employ the highest grade of legal talent to present its case with far more impressive strength, to interest the public to a greater degree through its stronger hold upon the press, and also to discover the majority view of automobilists upon the many questions which are still under discussion among them."

That such an organization would be for the general good of the community cannot be doubted. The wide use of motor vehicles, especially in large cities, will certainly be attended with greater cleanliness and freedom from the offensive filth which is involved in the presence of the horse, while the removal of stables will take away the main breeding place of flies and other disseminators of disease. The highway capacity of the crowded streets will be more than doubled, and the general use of smooth impervious pavements will be everywhere possible. That the introduction of such advantages, among many others, should be retarded and hindered by the obstinate prejudice of a few should not be permitted, and if the organization of a powerful association with all the influence which comes with numbers, information, legal support and counsel, and ample funds, can hasten the day of the automobile, by all means let such an organization be promptly formed and effectively supported throughout the United States and Canada.

Engineering Expeditions.

THE work of the civil and mining engineer often requires him to live away from civilization for months at a time, and unless he knows how to camp out and to keep himself and his party in good working condition under such circumstances, much time and effort may be lost.

In an excellent paper upon the equipment of camps and expeditions, Professor Charles H. Snow gave the American Institute of Mining Engineers some useful information in this line of work.

"The engineer has often to penetrate difficult or unknown regions. Mineral, irrigation, boundary, and railway problems frequently necessitate journeys through, or

long residence in localities whence sustenance cannot be drawn. The selection and conveyance of provisions, outfit and implements thus become a matter of first importance. Scientific skill, even of the highest order, is powerless unless supported by the proper appliances and foods. The advance of civilization favors the engineer, in that it is constantly enlarging his facilities and thus reducing his difficulties."

Taking up the subject in a systematic manner, Professor Snow considers successively transportation, food, packing, shelter, clothing, miscellaneous implements, instruments, personnel, and medicines, the last including camp hygiene.

Transportation is so much a local matter that it can be treated only in the broadest manner, but some excellent points from actual practice are given, among them being the not unnecessary hint that the native methods of a locality may be based on experience which it would not be wise to ignore.

Food is a matter about which much has been said of late in connection with military experience, and Professor Snow emphasizes the necessity of variety, if the food is to continue palatable and digestible. Such foods as must be used in expeditions are naturally deficient in nourishing power, and hence there is all the greater necessity for assisting digestion. This whole subject, including the so-called "emergency foods" is discussed at much length in the paper, and this portion is a valuable contribution to explorers as well as to engineers. A table of suggestions as to food combinations, with proportions and nourishing values is given for use in preparing an outfit.

While the instruments of a party must be largely determined by the nature of the work to be performed, yet there are some notes on the subject which are of general interest. Apart from the actual work of the expedition every member should be provided with a compass and should understand the art of tracing his way through forest or swamp. Several aneroids should be carried and observations made simultaneously when possible, in order to check the instruments and compare errors, and often data gained from the rough observations of explorers acquire a vast importance in boundary and

other disputes. A camera should always be carried, and with the compact instruments and films now made there is no reason why a full photographic record of an expedition should not be made in nearly every case.

The question of health is very important, and while there is no occasion for an elaborate medical outfit to be carried there are certain remedies and appliances which ought to form a portion of every equipment. Such an outfit is tabulated by Professor Snow with notes upon the uses of the various medicines and brief instructions as to the proper help to render in emergencies, and in the absence of a doctor, such instructions ought to be in the hands of every one.

The routine of camp hygiene should be drilled into every member of the party, since neglect of proper precautions by one may endanger the health of all the others and render all care useless.

As a summary, not only of his own experience, but also of that of many other engineers and explorers, Professor Snow's paper must be regarded as a most valuable contribution to the practical side of engineering, and had such methods as he emphasizes been enforced in all cases in the past there would have been success in many instances where failure has occurred.

Electric Delivery Wagons.

AN early application of the electrically propelled vehicle was its employment by the large department stores for delivery of purchases to customers. At first this use was doubtless prompted by a desire to turn the interest in the novel vehicles to advertising purposes, but experience has revealed the superiority of the motor delivery wagon over that drawn by horses. In a paper presented at the recent meeting of the American Institute of Electrical Engineers, Messrs. Sever and Fliess gave some interesting and valuable data concerning the actual operative costs of electrical delivery wagons.

A careful investigation of the amount of work done by delivery wagons hauled by horses shows that the work performed by a horse is 0.89 of a standard horse-power of 33,000 foot pounds per minute. Also that the cost per day for 2 horses, 1 driver and 1 boy is \$4.28.

In comparison with these figures, the data for automobiles were obtained from actual tests made in New York City, under varying conditions of grade and pavement, and in all kinds of weather, taking the readings from the volt and ampere meters. Data for a number of tests were given in the paper, and at the average speed of 10.5 miles per hour the power required was found to be 105 watt-hours per ton-mile, but in order to be on the safe side the rate was taken at 120 watt-hours per ton-mile, and this was the basis upon which the comparative costs of the electric and horse-drawn vehicles were computed. Making allowance for interest on the cost of the wagon, and taking all expenses into account, the cost per day for the electric delivery wagon is shown to be \$3.87 per day, a decided economy over the horse-drawn vehicle.

Apart from the mere operative economy in favor of the electric vehicle there are other important advantages. When not in operation, as on Sundays and holidays, no energy is consumed, while the cost of care and feed of horses continues whether any returns are made or not. The advantages of cleanliness and convenience have been enlarged upon elsewhere, but should never be lost sight of, while for the present at least, and until such vehicles become common the advertising element is unquestioned.

The real question of operative economy depends upon the price which must be paid for power, and this at the present time is a variable factor. As such vehicles come into general use they may become a valuable means of equalizing the load upon the power stations and by being charged at hours when the outside load is light they may be able to obtain very favorable terms. "Owing to the regular nature of the work imposed upon the wagons in delivery service it could easily be arranged to have the electric vehicles charged at night after the heavy load is off the station. They might also be charged early in the morning and at noon, or at periods which experience would indicate as most advantageous for the station, the time of deliveries being adjusted to suit the new conditions. In this way a stable should be able to buy power at from 1 to 2 cents per kw.-hour."

In general the conclusions from this valuable paper are:

"In light delivery service in large cities, when a number of units are employed by different firms, the adoption of the automobile would seem to be merely a question of time. For this kind of service it seems to be eminently the best solution. It is cheaper to operate than the horse service, and the mechanical problems have been so far solved as to make the vehicles commercially successful. Though it is not the intention to discuss depreciation, it may be noted that the comparison of the costs of operation as regards food, cost of power, etc., would show a saving in favor of the electric delivery wagon, in one year of 20 per cent., which under more favorable conditions as to the price of power, might easily be increased. Assuming, for the moment, that the depreciation in a year is 25 per cent. for the electric system, and, under the same service conditions, is only 10 per cent. for horse traction, we still have a saving of 5 per cent. in favor of the automobile."

Cooling Towers.

THE advantages of condensing engines are now so generally appreciated that in many places where an insufficient water supply is available attempts are made to obtain good results with a much smaller quantity of water than was formerly supposed possible.

Evaporative condensers have been installed in some places, but the more general plan is to cool the water after it has been once used and employ it over and over again, depending upon the local supply only to provide for the waste. Various methods have been adopted for this purpose, the oldest device being a shallow pond through which the water is made to circulate by partitions in such a manner that much of the heat is abstracted by contact with the air. In other cases the water from the hot well is discharged in spray, thus bringing it into intimate contact with the air, and the cooled drops collected in a pool for repeated use.

Of late the device known as the cooling tower has been employed, and various forms of this apparatus have been devised. In principle they are much alike. Water is

delivered to the top of a tower and allowed to descend in drops, films or other broken form while at the same time a current of air is caused to move in the opposite direction at a considerable speed, and when the proper proportions are observed the water which reaches the tank at the bottom is sufficiently cooled to be available for use again in the condenser.

A mathematical discussion of the theory of such cooling towers is given in a paper by Mr. W. A. Moss crop in a recent issue of *Engineering News*, and while it is not practicable to review the treatment in detail some of the essential features for successful design may be brought out here.

The real causes of cooling in a tower such as has been described above are; cooling by the evaporation of a portion of the water; and cooling by contact of the water with the air. To these may be added the cooling by contact with the walls of the tower, but this is an element so small that it may be neglected.

The degree of cooling which may be obtained by evaporation of moisture in free air is dependent upon the relative humidity of the atmosphere, that is, upon the amount of moisture already in it. This is well seen in the wet-and-dry-bulb thermometer, in which two thermometers are exposed, one with the bulb covered with moistened cotton, the other uncovered. The evaporation from the covered wet bulb produces a reduction in temperature, and from the difference in the readings of the two thermometers the amount of moisture in the air may be computed. No matter how diligently the wet bulb be fanned, or exposed to air currents the temperature will not fall below a definite point, dependent upon the relative humidity of the air at the time. In a dry climate like that of Colorado the reduction may be as much as 30 degrees or more, while in the moist air of the sea coast it may be only a few degrees. At the same time the velocity of the air current enters into the computation of the capacity of the cooling tower, as the moist air produced by the evaporation must be carried away immediately and replaced by fresh or the evaporation will soon cease. The cooling by contact with the air depends mainly upon the extent of surface exposed, and upon the difference in temperature, and from

these elements formulas may be deduced. At the present time there is a lack of experimental data upon which some of the constants in the formulas are based, but with the interest which is being given to the subject additional information upon these points should soon be available. At the present time, however, some suggestions upon the construction of cooling towers may be made.

Since the greatest source of cooling is the evaporation of a portion of the water, such towers will certainly be most effective at high altitudes and in dry climates, and these conditions obtain where water is scarce and where cooling towers are likely to be installed. Since the evaporation must take place from the surface of the water to be cooled it should be exposed to the action of the air in films, giving as great an extent of surface as possible, and breaking up and agitating the water as little as possible. Since the production of the air current requires power, it need not be given a greater velocity than is necessary to remove the moisture as rapidly as it is formed, and by observing wet and dry bulb thermometers suitably placed, the condition of the incoming and discharge air can be ascertained very readily. If the two bulbs in the discharged air stand at the same point the air is saturated, while the difference between them in the incoming air shows the maximum degree of cooling which may be attained. With ample means of obtaining information, based upon experience under various climatic conditions there appears to be no good reason why such cooling towers may not be proportioned as definitely as any other part of the power plant to which they belong.

Politics and Engineering.

It is one of the misfortunes which attends the execution of most great public works that engineering and politics cannot be separated, and that the skill and ability of the engineer is often confounded by the ignorance and incapacity, to call it by no worse name, of the politician. This is not only true of isolated cases, but is also an unfortunate feature of the conduct of those permanent engineering departments upon which the health and safety of large cities mainly depend.

In a recent issue of *Municipal Affairs* an article treating of this subject appears under the title of "A Tale of Two Cities," the concrete subject being the water supply question in London and in Philadelphia.

The comparison is interesting for several reasons, one among them being the fact that in London there are a number of private companies, while in Philadelphia the water works are owned and operated by the municipality, with a hungry corporation waiting in the background to capture them when possible.

Another interesting comparison between the two cases appears in the fact that in London the per capita consumption is the smallest of all in a table of many large cities, while in Philadelphia the amount supplied per head is the next to the top of the list. In London the supply is 37 gallons per head per day, while in Philadelphia it is 166.15 gallons!

Two things result from this state of affairs. In London there is an outcry against the insufficient supply, while in Philadelphia there is a demand for the reduction of waste in order that a purer article may be supplied. Since the charges in London are based, not upon the supply but upon the property valuation, there is naturally much objection to the meagreness of the supply.

"The complaint against the water companies is not only that there is no competition, that the plants are overcapitalized, that the rates are excessive, and that the charges are increasing annually without a corresponding increase in the character of the service but that the supply is entirely inadequate. Every year, as certain as the warm weather of the summer months comes, there is a water famine in East London which affects one-fourth the population of the city. Beginning in August, it lasts until October or December, and during these months the water supply is often shut off eighteen or twenty hours out of the twenty-four, and each person is obliged to store what water he wishes to use in jars, pans, etc. Such a course is impracticable among the poorer classes—those who most need an abundant supply for sanitary purposes. Then, too, the quality of the water is such that after it has stood some time it becomes positively distasteful and its stale odor is extremely disagreeable.

"So great is the famine that the public authorities loan thousands of jars and pans to the people, and even undertake to furnish a very limited supply of water from carts. The first city in the world, with a people noted for its great industrial ability, is thus dependent upon the primitive methods of water carriers for what is everywhere recognized to be one of the first essentials of civilization."

Turning now to Philadelphia there is another story none the less discreditable. Water there is, but it is foul with disease and the germs of death. The Schuylkill, from which the supply is derived, is practically an open sewer, and the demand for water which the excessive waste has created renders it necessary that this foul stuff must be pumped directly into the mains, the capacity of the plant not permitting opportunity for subsidence, much less filtration. As a result Philadelphia, from being one of the most healthful cities in the United States, has now a typhoid fever death rate which gives it an unenviable prominence among all the great cities of the world. "From January 1 to May 10, 1899, there were over 6,000 cases of typhoid fever reported to the Board of Health, and 677 deaths. Should the death rate for the remainder of the year fall to normal, there would be at least 900 deaths from typhoid alone—the abnormal death rate of over 70 per 100,000; a rate that is exceeded in very few civilized cities in the world and which is far above that of nearly all American and European cities."

Philadelphia is preparing at the present time to open a great exposition, but with this prospect before them one is led to question the advisability of placing such a state of affairs on public exhibition.

This condition of affairs is altogether the result of the interference of the politician with the work of the engineer. Philadelphia has at the head of its Bureau of Water one of the ablest and best-known engineers in the United States, Mr. John C. Trautwine, Jr., and his able and fearless reports have shown how well he understands the subject. His hands have been tied and his recommendations ignored. The evidence of waste has been neglected, and the only method by which filtration can be secured, *i. e.*, the introduction of meters to bring

the quantity of water to be treated within practicable limits, has been opposed by the politicians.

In order to show how little the magnitude of the problem is realized it may suffice to know that the present chief magistrate of the city before taking his seat said: "I propose to study the water question from beginning to end. When I have thoroughly mastered all points I will decide on the plan which I think is best. *I expect to devote the greater part of the next ten days to the subject.*" The italics are ours. Truly he had the courage of his ignorance.

When politicians undertake to do in ten days what no competent engineer would venture to attempt, with all his previous training, for many months, surely it is time for the people of the fever stricken city to act.

Water-Power Governing.

WITH the extensive utilization of hydraulic power for the generation of electricity there has arisen a demand for more accurate speed regulation than was formerly deemed necessary. In this respect there is a marked analogy to the improvement in the government of steam engines which was brought about by the development of electric lighting. Water wheel governing however, involves a number of more difficult problems than those which appear in steam engine governing, and this side of the subject formed the theme of a paper before the American Institute of Electrical Engineers, by Mr. A. V. Garratt.

In the case of steam it is only necessary to vary either the steam inlet or the point of cut-off and the speed promptly responds. With water power, and especially with the modern high pressure wheels, we have to deal not with a light, elastic fluid, but with a heavy, incompressible material, and problems of inertia must be dealt with. Not only is there a large mass of moving water, but there are also gates having weight and frictional resistance, and the momentum and inertia of these elements form matters which demand consideration. When, as is not infrequently the case, a large portion of the load is suddenly thrown off a wheel operating at full gate a great amount of energy must be absorbed, and the extent to which this is sometimes the

case is shown by a numerical example. It is, of course, desirable to keep the pressure constant on a wheel, but in practice this is found to be impossible. Remedies which have been used to help meet this point are, the use of relief valves near the wheel case, so arranged that they will open when the proper static head is exceeded, or standpipes. When it is especially desired that sudden changes of load should not materially affect the speed, a standpipe is a valuable auxiliary, and in some instances fly wheels are also used. With the modern hydraulic and electric power plants, however, there is rarely any need of fly wheels, since the various rotating parts, including the wheel itself, the armature, pulleys, etc., have a sufficient moment of inertia and angular velocity to enable a first-class governor to hold the speed within satisfactory limits.

The use of the draft-tube must be considered in connection with speed regulation, and it is not advisable to use the full length which may be available, since the atmospheric pressure may produce a water-hammer effect if the wheel is suddenly shut down. The draft-tube, if used, should be short and as nearly vertical as possible, while the greater the angle of descent given

to the water in the flume the better for purposes of regulation.

When a plant has not been well-designed from a hydraulic point of view it may sometimes be improved by the application of fly wheels, so arranged as to absorb the energy and give it out again before the changes can reach the wheel, but it is often better to correct the design of the plant and install good governing devices.

While reliable governors are doubtless most important appliances, the question of speed regulation may also be considered in another light, *i. e.*, in connection with prevention rather than cure. Instead of attempting to adjust the power to every sudden change in load, every effort should be made to equalize the load itself. Just as the hydraulic stand-pipe has been used to equalize the water pressure, so the storage battery may be used to equalize the demand upon the wheels. When a wheel is operated under a fairly constant head and the plant is provided with storage capacity sufficient to equalize the demands which may come for power, we have a form of fly-wheel which should materially simplify the problems in connection with the speed regulation of hydraulic power plants.

THE ENGINEERING INDEX

INTRODUCTORY.

The object of this Index is to supply all persons interested in engineering and industrial pursuits with, first, an expert descriptive summary clearly indicating the character and purpose of the leading articles published currently in the established technical journals of the United States, Great Britain, and the Continent—in all languages; and, secondly, an inexpensive means of readily obtaining such portions of this literature as may be desired.

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THE PUBLICATIONS REGULARLY REVIEWED AND INDEXED.

The titles and addresses of the journals regularly reviewed are given here in full, but only abbreviated titles are used in the Index. In the list below, *w* indicates a weekly publication, *b-w*, bi-weekly, *s-w*, a semi-weekly, *m*, a monthly, *b-m*, a bi-monthly, *qr*, a quarterly, *s q*, semi-quarterly, etc. Other abbreviations used in the Index are: Ill—Illustrated; W=Words; Anon=Anonymous.

American Architect. *w*. Boston, U. S. A.
American Electrician. *m*. New York.
Am. Engineer and Railroad Journal. *m*. New York.
American Gas Light Journal. *w*. New York.
American Geologist. *m*. Minneapolis, U. S. A.
American Journal of Science. *m*. New Haven, Conn.
American Machinist. *w*. New York.
Am. Manufacturer and Iron World. *w*. Pittsburg.
American Shipbuilder. *w*. New York.
Am. Soc. of Irrigation Engineers. *qr*. Denver
Annales des Ponts et Chaussées. *m*. Paris.
Architect. *w*. London.
Architectural Record. *q*. New York.
Architectural Review. *s-q*. Boston, U. S. A.
Architecture and Building. *w*. New York.
Architektonische Rundschau. *m*. Stuttgart.
Australian Mining Standard. *w*. Sydney.
Automotor and Horseless Vehicle Jour. *m*. London.
Berg-und Hüttenmännische Zeitung. *w*. Berlin.
Brick Builder. *m*. Boston, Mass.
Bridges. *m*. Chicago.
British Architect. *w*. London.
Builder. *w*. London.
Bulletin Am. Iron and Steel Asso. *w*. Phila.
Bulletin de la Société d'Encouragement. *m*. Paris.
Bulletin of Dept. of Labor. *b-m*. Washington.
Bulletin of the Univ. of Wisconsin, Madison, U.S.A.
Bull. Int. Railway Congress. *m*. Brussels.

California Architect. *m*. San Francis co.
Canadian Architect. *m*. Toronto.
Canadian Electrical News. *m*. Toronto.
Canadian Engineer. *m*. Montreal.
Canadian Mining Review. *m*. Ottawa.
Chem.Met.Soc.of S. Africa. *m*. Johannesburg.
Colliery Guardian. *w*. London.
Compressed Air. *m*. New York.
Comptes Rendus de l'Acad. des Sciences. *w*. Paris.
Consular Reports. *m*. Washington.
Contemporary Review. *m*. London.
Deutsche Bauzeitung. *b-w*. Berlin.
Dingler's Polytechnisches Journal. *w*. Stuttgart.
Domestic Engineering. *m*. Chicago.
Eclairage Electrique. *w*. Paris.
Electrical Engineer. *w*. London.
Electrical Engineering. *m*. Chicago, Ill.
Electrical Review. *w*. London.
Electrical Review. *w*. New York.
Electrical World. *w*. New York.
Electrician. *w*. London.
Electricien. *w*. Paris.
Electricity. *w*. London.
Electricity. *w*. New York.
Elektrochemische Rundschau. *b-m*. Frankfurt.
Elektrochemische Zeitschrift. *m*. Berlin.
Elektrotechnisches Echo. *w*. Magdeburg.
Electrotechniker. *b-m*. Vienna.

- Elektrotechnischer Anzeiger. *s-w.* Berlin.
 Elektrotechnische Zeitschrift. *w.* Berlin.
 Eletticità, *w.* Milan.
 Engineer. *w.* London.
 Engineer. *s-m.* Cleveland, U. S. A.
 Engineers' Gazette. *m.* London.
 Engineering. *w.* London.
 Engineering Assn. of the South. Nashville, U.S.A.
 Engineering and Mining Journal. *w.* New York.
 Engineering Journal. *s-an.* Stanford Univ., Cal.
 Engineering Magazine. *m.* New York & London.
 Engineering News. *w.* New York.
 Engineering Record. *w.* New York.
 Eng. Soc. of the School of Prac. Sci. Toronto.
 Eng. Soc. of Western Penn'a. *m.* Pittsburg, U.S.A.
 Fire and Water. *w.* New York.
 Foundry. *m.* Detroit.
 Gas Engineers' Mag. *m.* Birmingham.
 Gas World. *w.* London.
 Génie Civil. *w.* Paris.
 Gesundheits-Ingenieur. *s-m.* München.
 Giorn. Dei Lav. Pubbl. e d. Str. Ferr. *w.* Rome.
 Glaser's Ann. f. Gewerbe & Bauwesen. *s-m.* Berlin.
 Heating and Ventilating. *m.* New York.
 Horseless Age. *w.* New York
 Ice and Refrigeration. *m.* New York.
 Ill. Carpenter and Builder. *w.* London.
 Illinois Soc. of Engs and Surveyors. Peoria, U.S.A.
 India Rubber World. *m.* New York.
 Indian and Eastern Engineer. *m.* Calcutta.
 Industries and Iron. *w.* London.
 Inland Architect. *m.* Chicago.
 Iron Age. *w.* New York.
 Iron and Coal Trades Review. *w.* London.
 Iron & Steel Trades Journal. *w.* London.
 Iron Trade Review. *w.* Cleveland.
 Jour. Am. Soc. Naval Engineers. *qr.* Wash., D. C.
 Journal Assn. Eng. Societies. *m.* Phila., Pa.
 Journal of Electricity. *m.* San Francisco.
 Journal Franklin Institute. *m.* Philadelphia.
 Journal of Gas Lighting. *w.* London.
 Jour. N. E. Waterw. Assoc. *qr.* New London, Conn.
 Journal Royal Inst. of Brit. Arch. *s-qr.* London.
 Journal of Sanitary Institute. *qr.* London.
 Journal of the Society of Arts. *w.* London.
 Journal of U. S. Artillery. *b-m.* Fort Monroe, Va.
 Journal Western Soc. of Eng. *b-m.* Chicago, Ill.
 Journal of Worcester Pol. Inst. Worcester, Mass.
 Kansas University Quarterly. *qr.* Lawrence, Kans.
 La Ingenieria. *m.* Buenos Aires, Argentina.
 L'Energie Electrique. *w.* Paris.
 Locomotive. *m.* Hartford, U. S. A.
 Locomotive Engineering. *m.* New York.
 Machinery. *m.* London.
 Machinery. *m.* New York.
 Marine Engineer. *m.* London.
 Marine Engineering. *m.* New York.
 Marine Review. *w.* Cleveland, U. S. A.
 Master Steam Fitter. *m.* Chicago.
 Mechanical World. *w.* London.
 Mechanical Engineer. *w.* Manchester.
 Mem. de la Soc. des Ing. Civils de France. *m.* Paris.
 Metal Worker. *w.* New York.
 Mines and Minerals. *m.* Scranton, U. S. A.
 Mining and Sci. Press. *w.* San Francisco, U.S.A.
 Mining Journal. *w.* London.
 Mining Reporter. *w.* Denver, U. S. A.
 Mitt. aus d. Kgl. Tech. Versuchsanst. Berlin.
 Mittheilungen des Vereines für die Förderung des
 Local- und Strassenbahnwesens. *m.* Vienna.
 Modern Machinery. *m.* Chicago.
 Moniteur des Architectes. *m.* Paris.
 Moniteur Industriel. *w.* Paris.
 Municipal Affairs. *qr.* New York.
 Municipal Engineering. *m.* Indianapolis, U. S. A.
 National Builder. *m.* Chicago.
 Nature. *w.* London.
 Nature. *w.* Paris.
 New Zealand Mines Record. *m.* Wellington, N. Z.
 Nineteenth Century. *m.* London.
 Oest. Monatsschr. f. d. Oeff. Baudienst. *m.* Vienna.
 Oest. Zeitschr. f. Berg- & Hüttenwesen *w.* Vienna.
 Ores and Metals. *w.* Denver, Colo.
 Plumber and Decorator. *m.* London.
 Popular Science Monthly. *m.* New York.
 Power. *m.* New York.
 Practical Engineer. *w.* London.
 Pro. Am. Soc. Civil Engineers. *m.* New York
 Proceedings Engineers' Club. *qr.* Phila.
 Proceedings of Central Railway Club.
 Pro. of Purdue Soc. of C. E. *yr.* La Fayette, U.S.A.
 Progressive Age. *s-m.* New York.
 Railroad Car Journal. *m.* New York.
 Railroad Gazette. *w.* New York.
 Railway Age. *w.* Chicago.
 Railway Magazine. *m.* New York.
 Railway Master Mechanic. *m.* Chicago.
 Railway & Engineering Review. *w.* Chicago.
 Railway World. *m.* London.
 Review of Reviews. *m.* New York.
 Revista de Obras Públicas. *w.* Madrid.
 Revue de Mécanique. *m.* Paris.
 Revue Gen. des Chemins de Fer. *m.* Paris.
 Revue Technique. *b-m.* Paris.
 Revue Universelle des Mines. *m.* Liège.
 Rivista Marittima. *m.* Rome.
 Sanitarian. *m.* Brooklyn, U. S. A.
 Sanitary Plumber. *s-m.* New York.
 School of Mines Quarterly. New York.
 Schweizerische Bauzeitung. *w.* Zürich
 Scientific American. *w.* New York.
 Scientific Am. Supplement. *w.* New York.
 Seaboard. *w.* New York.
 Sibley Journal of Eng. *m.* Ithaca, U. S. A.
 Stahl und Eisen. *s-m.* Düsseldorf.
 Stevens' Indicator. *qr.* Hoboken, U. S. A.
 Stone. *m.* New York.
 Street Railway Journal. *m.* New York.
 Street Railway Review. *m.* Chicago, Ill.
 Technology Quarterly. Boston.
 Terrestrial Magnetism. *qr.* Cincinnati, O.
 Trans. Assn. C. E. of Cornell Univ. Ithaca, U. S. A.
 Trans. Am. Ins. Electrical Eng. *m.* New York.
 Trans. Am. Ins. of Mining Eng. New York.
 Trans. Am. Soc. of Civil Engineers. *m.* New York.
 Trans. Am. Soc. of Heat. & Ven. Engrs. New York.
 Trans. Am. Soc. Mech. Engineers. New York.
 Transport. *w.* London.
 Western Electrician. *w.* Chicago.
 Western Railway Club Pro. Chicago.
 Wiener Bauindustrie Zeitung. *w.* Vienna.
 Wisconsin Engineer. *qr.* Madison, Wis.
 Yale Scientific Monthly. *m.* New Haven, U. S. A.
 Year Book of Soc. of Engs. Univ. of Minn.
 Zeitschr. d. Oest. Ing. u. Arch. Ver. *w.* Vienna.
 Zeitschr. d. Ver. Deutscher Ingen. *w.* Berlin.
 Zeitschrift für Elektrochemie. *s-m.* Halle a. S.
 Zeitschrift für Elektrotechnik. *s-m.* Halle a. S.

ARCHITECTURAL ENGINEERING

CONSTRUCTION.

Bridge Architecture.

See Civil Engineering, Bridges.

Convention Hall.

The Kansas City Convention Hall. Illustrated description of a hall seating 25,000 people, in which some of the galleries are suspended from roof trusses of 187 ft. span. 1500 w. Eng Rec—July 22, 1899. No. 28683.

Cyclorama.

The Cyclorama Building in the Prater at Vienna (Rundgemälde-Gebäude un Prater in Wien). Oskar Marmorek. With view of entrance, and plan on section showing details of construction. 1000 w. Wiener Bauindustrie Zeitung—July 6, 1899. No. 28774 B.

Exposition.

The Building of Mines and Metallurgy (Palais des Mines et de la Métallurgie). René Weil. A description of the building now under construction for the Paris Exposition, with plans and views of the present state of the work. The computation of the stresses on the frames is given. 3500 w. 1 plate. Génie Civil—July 1, 1899. No. 28704 D.

Fireproofing.

Scagliol and Petrura. Information relating to two fire-resisting materials being introduced in London. 700 w. Builder—July 8, 1899. No. 28621 A.

Test of Wide Floor Arches. Corydon T. Purdy. Gives an illustrated description of a test of two 7 ft. arches, one segmental and the other flat. 1200 w. Br Build—July, 1899. No. 28813 C.

Hospital.

Engineering Features in the Alexian Brothers' Hospital, Chicago. Description with illustrations, of a hospital where all the arrangements are on sanitary principles. 1800 w. Eng News—July 20, 1899. No. 28675.

Reinforced Concrete.

Groined Steel Roof Arches. Illustrated description of gothic arches made of steel shapes bent by special machines, which are explained, and covered with concrete to give the effect of solid masonry. 600 w. Eng Rec—July 8, 1899. No. 28519.

Schools.

The Planning and Construction of Board Schools. T. J. Bailey. An account of the building work of the London School Board, discussing sites, build-

ings, warming and ventilation, etc. Ill. Discussion. 1200 w. Jour Roy Inst of Brit Archts—June 3, 1899. No. 28589 B.

Stability.

The Effect of Bell Ringing on the Stability of Towers (Beobachtung von Thurmschwingungen beim Läuten der Glocken). J. Bürgin. Giving data and results of micrometric measurements upon a tower in which heavy bells were rung. Two articles, 3000 w. Deutsche Bauzeitung—June 28, 30, 1899. No. 28775 each B.

Stables.

Two Noteworthy New York Stables. Illustrated description of the construction and architectural fittings of the stables of H. O. Havemeyer, and O. H. Payne. 3200 w. Eng Rec—July 15, 1899. No. 28598.

Vienna.

Foundation Work in Vienna (Ueber die Fundirungsverhältnisse in Wien). Ferd. Dehm. An elaborate account of the strata underlying the city of Vienna with regard to the construction of building foundations. 7500 w. Zeitschr d Oesterr Ing u Arch Ver—June 23, 1899. No. 28727 B.

HEATING AND VENTILATION.

Fans.

The Calculation of Centrifugal Fans for Ventilating Purposes. H. Eisert. Read at the Saratoga meeting of the Am. Soc. of Heat. & Ven. Engs. An account of the investigations of the writer. 5000 w. Heat & Ven—July, 1899. No. 28809.

Hospital Heating.

A Hospital Central Heating Plant. Illustrated description of a central power house and heating plant for the Bellevue Hospital, New York. 1300 w. Eng Rec—July 22, 1899. No. 28686.

Hot Water System.

A Combined Direct and Indirect Hot Water System. Plans of the building are given with description of a successful heating plant. Two other plants proved unsuccessful. 800 w. Met Work—July 15, 1899. No. 28591.

Paris Exposition.

Description of Arrangement for Heating and Ventilating Exhibit at Paris Exposition, 1900. W. F. Wolfe. Read at the Saratoga meeting of the Am. Soc. of Heat & Ven. Engs. Information regarding space, classification, attendance, etc. 2000 w. Heat & Ven—July, 1899. No. 28810.

We supply copies of these articles. See introductory.

Steam Conduits.

Steam Pipe Conduits and the Distribution of Steam to Scattered Buildings. An editorial discussion of the best types of construction with an accompanying illustrated article on the system at Dartmouth College. 2100 w. Eng Rec—July 8, 1899. No. 28512.

Steam Heating.

Heating with Steam at or Below Atmospheric Pressure. J. H. Kinealy. Read at Saratoga meeting of the Am. Soc. of Heat. & Ven. Engs. Describes investigations made and conclusions reached. 6500 w. Heat & Ven—July, 1899. No. 28811.

Tall Buildings.

Some Points Regarding the Ventilation and Heating of Tall Buildings. Henry C. Meyer, Jr. Discusses various types of apparatus used. 2500 w. Dom Engng—July, 1899. No. 28652 C.

PLUMBING AND GAS FITTING.**Club House.**

Plumbing in the New York Athletic Club House. Illustrated description of noteworthy work, including a special form of mechanical filter. 2400 w. Eng Rec—July 29, 1899. No. 28839.

Leaks.

Leaks in Plumbing Work. Alex. W. Murray. Considers leaks in connections

beneath the surface of the ground, or under basement floors, and how to protect and repair them. Ill. 2500 w. Dom Engng—July, 1899. No. 28651 C.

MISCELLANY.**Building Inspection.**

The Building Department of Boston, Mass. A statement of the results of an investigation by a special committee representing the local master builders, fire underwriters, architects and real estate dealers, into the manner in which the building laws of Boston are enforced. 2300 w. Eng Rec—July 8, 1899. No. 28511.

Mechanical Plant.

The Mechanical Plant of the Park Row Building, New York. Describes the engine, boiler, dynamo, elevator, ventilating and heating plant in a building 390 feet high and having 8 acres of floor surface. Many of the features are novel. Ill. 3000 w. Eng Rec—July 1, 1899. No. 28445.

Timber.

Timber and Timber Structures. T. Roger Smith. A lecture delivered at Carpenter's Hall, London. Deals with its preparation and care as a material of carpentry and joinery, and its use in the construction of buildings. 7000 w. Build-er—June 24, 1899. No. 28426 A.

CIVIL ENGINEERING**[BRIDGES.]****Alexander III.**

The Alexander III. Bridge. Brief illustrated description of the work and of the processes adopted in its erection. 1800 w. Engng—July 14, 1899. Serial. 1st part. No. 28694 A.

The Alexander III. Bridge Over the Seine (Pont Alexandre III. sur la Seine). E. Rouyer. Especially devoted to the construction of the false-work truss and the erection of the arch ribs. 2000 w. 1 plate. Génie Civil—July 8, 1899. No. 28705 D.

Arch.

A Stone Arch Rib Railroad Bridge. Illustrated description of three 60-ft. masonry spans, each consisting of a pair of masonry ribs placed side by side like trusses. 500 w. Eng Rec—July 8, 1899. No. 28513.

The Forbes Street Bridge, Pittsburg, Pa. Illustrated description of an old and a new arch bridge of about 150 ft. span, showing the development of structural

work of this type in the last 25 years. 2500 w. Eng Rec—July 15, 1899. No. 28593.

Bridge Architecture.

The Architectural Element in Engineering Works. H. Heathcote Statham. Discusses various types of bridge architecture showing the attention given to this branch of engineering, especially during the 19th century. 12200 w. Jour Roy Inst of Brit Archts—May 20, 1899. No. 28476 B.

Cantilever.

Cantilever Bridge at Lewiston, Idaho. Illustrates and describes a recently completed bridge of considerable interest from an engineering standpoint. 1100 w. Ry & Eng Rev—July 8, 1899. No. 28533.

Corrosion.

The Protection of Overhead Bridges from Locomotive Gases. Editorial discussion of this subject and the need of reform in engineering practice, with sug-

gestions for remedying the trouble. 1500 w. Eng News—July 20, 1899. No. 28677.

Drawbridge.

Replacing the Newark Draw. Illustrated description of the method employed to replace a 400-ton draw span with one of 600 tons, with a minimum interference with river and rail traffic. 1700 w. Eng Rec—July 29, 1899. No. 28838.

Erection.

The Erection of Iron Bridges in America (Die Aufstellung Eiserner-Brücken in Amerika). Carl Bernhard. A description of the rapid methods of erection used by the American builders of iron bridges. Two articles, 7000 w. Zeitschr d Ver Deutscher Ing—July 8, 15, 1899. No. 28724 D.

French Bridges.

Notes on Recent French Bridge Construction. Notes and illustrations explaining details of interesting structures of recent date. 1500 w. Eng News—July 6, 1899. No. 28457.

Stone Bridges.

Stone Masonry Bridges. Extracts from a paper by Mr. Owen Morris. Brief notes both historical and descriptive. 1400 w. Stone—July, 1899. No. 28823 C.

CONSTRUCTION.

Reinforced Concrete.

Test of a Concrete-Iron Girder (Probelastung einer Gurtträgerbrücke). M. Möller. Details of tests of reinforced concrete beam of 15 metres span, loaded uniformly to destruction, with photographs of the structure before and after testing. 1200 w. Deutsche Bauzeitung—July 5, 1899. No. 28776 B.

See Architectural Engineering, Construction.

Roads.

Roads: Their Construction and Maintenance. Part first considers the nature of the materials available, their merits and disadvantages. 2000 w. Builder—July 1, 1899. Serial. 1st part. No. 28542 A.

The Work of General Gallieni in Madagascar. From *Le Monde Illustré*. An account of road construction on the Indian Ocean side of the island, which will in time be mentioned as one of the most beautiful roads in the world. Ill. 900 w. Sci Am Sup—July 8, 1899. No. 28449.

Shed Extension.

See Railway Affairs, Permanent Way.

Steel Pier.

The Atlantic City Steel Pier. Illustrated description of a structure 1,600 ft. long and 40 to 120 ft. wide, carried on shoe piles of novel form. 1700 w. Eng Rec—July 1, 1899. No. 28441.

Tunnels.

Notes on Tunneling. Abstract of remarks by Sir Benjamin Baker on the behavior of earth through which tunnels are driven. 1300 w. Eng Rec—July 8, 1899. No. 28518.

The Irish Channel Tunnel Scheme. Editorial on the scheme to construct a tunnel between Scotland and Ireland. 1600 w. Engr, Lond—July 14, 1899. No. 28699 A.

The North Bessemer Tunnel. F. E. House. Read before the Engs.' Soc. of W. Penna. Describes the construction and the causes for change of plans. 2200 w. R R Gaz—July 7, 1899. No. 28500 W.

The Work on the Simplon Tunnel (I Lavori del Sempione). Pietro Biraghi. A discussion of the quarterly report of the work both at the north and south ends, and a description of the power plants at each entrance. Three articles, 5000 w. Rivista Gen del Ferrovie—May 7, 15, 21, 1899. No. 28773 each B.

HYDRAULIC AND MARINE.

Breakwaters.

The Delaware Breakwater. Condensed from report of C. W. Raymond. Illustrated description of a random-stone breakwater which departs in many respects from the accepted practice based on the Cherbourg breakwater. 2200 w. Eng Rec—July 8, 1899. No. 28517.

Canal.

The Latest Plans for the Panama Canal (Des Panama-Canal nach dem Neuesten Entwürfe). A review of the report of the Technical Commission upon the Panama Canal, showing the cost of completion and the general condition of the work. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—June 30, 1899. No. 28728 B.

The Rhine-Elbe Canal (Der Rhein-Elbe Kanal). A review of the conditions which have led to the present demand for the extension of internal water-ways in Germany, with map and profile of the proposed canal between the Rhine and the Elbe. Two articles, 7500 w. Glaser's Annalen—July 1, 15, 1899. No. 28740 each D.

Tail Race of the Chicago Drainage Canal. Gives the original plan for the tail race, and also the present plan, explaining why the change was made. Ill. 1100 w. Eng News—July 6, 1899. No. 28454.

Canal Lift.

Canal Lift Without Gates or Locks (Schiffshebewerk ohne Haltungsthore und Schleusen). A very complete account of the Tentschert-Czischek system, in which the canal boat is floated into a cylindrical tank and rolled up an inclined plane by rope tackle. 4000 w. Zeitschr d Oesterr Ing u Arch Ver—July 7, 1899. No. 28730 B.

Coast Protection.

Foreshore Protection, with Special Reference to the Case System of Groyning. R. G. Allanson-Winn. Read before the Soc. of Eng. Describes certain methods which have recently found favor in shore protection, giving examples of works carried out under different conditions. 3400 w. Ind. & Ir—June 23, 1899. Serial. 1st part. No. 28436 A.

Computations.

A New Method of Computing Hydraulic Problems (Ueber ein Neues Rechenungsverfahren bei Aufgaben der Hydraulik). J. B. Goebel. A mathematical discussion, deriving algebraic formulas and showing their application to the flow of water through pipes. Serial. Part I. 2500 w. Gesundheits-Ingenieur—June 15, 1899. No. 28731 B.

Dam.

Geology of the Wachusett Dam and Wachusett Aqueduct Tunnel of the Metropolitan Water Works in the Vicinity of Clinton, Mass. W. O. Crosby. The present paper considers the hard rocks of this district, their distribution, characters, and general relations, with the structural details of the site of the dam. Ill. 11000 w. Tech Quar—June, 1899. No. 28520 E.

The New Masonry Dam at Holyoke. Illustrated description of a dam across the Connecticut River which has an unusual profile on the downstream face, and is being laid with special precautions to secure good workmanship. 1800 w. Eng Rec—July 22, 1899. No. 28682.

Docks.

Water Front Engineering in American Cities. Report of an investigation made by H. C. Holmes for the California State Harbor Commission. Part first gives the organization of the water front commission of Boston, New York and Philadelphia, and describes the construction of wharves in New York. 3900 w. Eng Rec—July 8, 1899. Serial. 1st part. No. 28516.

Dredging.

Alexander McDougall's Dredging System. Illustrates and describes a dredging machine for use in placer mining. 2100 w. Mod Mach—July, 1899. No. 28492.

Bucket Dredging Machine. Description with illustrations of a sea-going bucket dredger constructed for the Russian Government. 500 w. Engng—June 23, 1899. No. 28439 A.

The Largest Dipper Dredge Ever Built. Illustrates and describes a large dipper dredge recently built for use on the Great Lakes. 1500 w. Eng News—July 13, 1899. No. 28574.

The New Bates Hydraulic Dredger for the Volga. Illustrated description of a

centrifugal dredge propelled by electricity and provided with cutters and a pontoon line containing many new features. 2000 w. Eng Rec—July 22, 1899. No. 28685.

Dry Dock.

The Failure of a Timber Dry-Dock. Describes the failure of Dock 2 of the Brooklyn navy yard, after nine years of service. 800 w. Eng Rec—July 29, 1899. No. 28840.

The New Dry-Dock for the U. S. Navy at Boston, Mass. Plans and description of a dock to be built of concrete, with rubble stone fillers, and lined with cut stone masonry. 1800 w. Eng News—July 20, 1899. No. 28678.

Flow.

Logarithmic Diagram for Flow of Water in Clean Cast-Iron Pipes Under Pressure. Gives a diagram devised by A. Van Muyden and reconstructed by George T. Prince with American measurements, with directions regarding its use. 900 w. Eng News—July 6, 1899. No. 28452.

Graving-Docks.

Graving-Dock Blocks and Appliances. Arthur John Maginnis. Read before the Engng. Conference of the Inst. of Civ. Eng., England. Considers keel blocks, side shores, and lifting appliances. 1600 w. Engs' Gaz—July, 1899. No. 28588 A.

New Graving Dock at Troon. Describes a recently opened dock which has been under construction for two years. Ill. 1800 w. Engr, Lond—July 14, 1899. No. 28697 A.

Harbor Improvements.

Harbor Improvements at Victoria. Extracts from the *Victoria Colonist* giving an outline of the scheme. The estimated outlay is about \$5,290,000. 1000 w. U. S. Cons Repts, No. 476—July 14, 1899. No. 28590 D.

Italy.

The Utilization of the Water Powers of Italy. Enrico Bignami. A review of the possibilities which the innumerable water powers of Italy offer for the industrial salvation of the country. 4500 w. Engineering Magazine—August, 1899. No. 28783 B.

New Britain, Conn.

Roaring Brook Utilized at New Britain. An account of the work necessary to avail itself of this supply, which is drawn from a watershed of about 1,600 acres. Ill. 1000 w. Fire & Water—July 8, 1899. Serial. 1st part. No. 28532.

Pipe Lines.

Some Notable Australian Steel Pipe Lines. Information concerning the steel

pipe line with locking-bar joints, which forms a part of the water-works of Adelaide, Western Australia. Ill. 1500 w. Eng News—June 29, 1899. No. 28404.

Tide Gate.

Twin Tide Gate for the Swanson Street Canal Outlet, Philadelphia, Pa. Harrison Souder. Illustrates and describes the construction. 1000 w. Eng News—July 20, 1899. No. 28674.

Turbid Waters.

On Rapid Methods for the Estimation of the Weight of Suspended Matters in Turbid Waters. Charles L. Palmerlee and Joseph W. Ellms. A discussion in detail of the difficulties of accurate and rapid determination, noting the factors which influence the processes, and discussing methods. 7000 w. Tech Quar—June, 1899. No. 28522 E.

Water Supply.

A Tale of Two Cities: Water Supply in London and Philadelphia. Milo Roy Maltbie. Cites London as an example of private monopolies serving so poorly as to endanger the health of the people; and Philadelphia as showing official mismanagement and depreciation for the purpose of forcing the city to surrender to a corporation. 7500 w. Munic Af—June, 1899. No. 28447 C.

The New Water Supply System of Rockford, Ill. Gives an outline of the various attempts made to supply this city with an abundance of pure water, and gives an illustrated description of the interesting plant for supplying artesian water. 2500 w. Eng News—July 13, 1899. No. 28573.

Water Waste.

Preventing Water Waste in Newark, N. J. Describes an inspection to determine all the features of plumbing in houses in this city where waste is believed to occur. 1000 w. Eng Rec—July 15, 1899. No. 28596.

Water Consumption and Waste in Great Britain. A summary of the views of a number of managers of large British works, given at the convention of the Inst. of Civ. Eng. 3000 w. Eng Rec—July 15, 1899. No. 28597.

Water Works.

"All Persons Who Deal With Public Officials Act at Their Peril." Review of an important decision by the Georgia Supreme Court annulling a contract between a city and a water company because it ran for a longer term than one year, and because certain preliminaries were irregular. 1500 w. Eng Rec—July 15, 1899. No. 28592.

Notes on the Albany Water Works. Gives hints concerning hydrant maintenance and the prevention of water waste.

1100 w. Eng Rec—July 1, 1899. No. 28443.

The New Water Works of Dresden (Das Neue Dresdener Wasserwerk). A description, by Chief Engineer Vacherot, of the new system of wells and pumping engines by which the city of Dresden is supplied with water. 3000 w. 1 plate. Zeitschr d Ver Deutscher Ing—July 1, 1899. No. 28720 D.

The Water Supply of Scutari and Kadiköi (Die Wasserversorgung von Skutari und Kadiköi). Adolf Friedrich. A general description of the new water supply for 100,000 inhabitants of the suburbs of Constantinople, by impounding small streams in the adjacent valleys. 2500 w. 1 plate. Oesterr Monatschr f d Oeffent Baudienst—July, 1899. No. 28734 D.

MATERIALS.

Buckling.

The Elementary Derivation of the Formula for Buckling (Die Elementare Ableitung der Knickformel). W. Schüle. A discussion of the formula for the resistance of columns to buckling, showing how the formula may be derived without the use of the calculus. 1000 w. Zeitschr d Ver Deutscher Ing—July 1, 1899. No. 28722 D.

Cement.

Chemical Tests of Cement. John F. Wixford and S. Bent Russell. Gives the method of testing used in the chemical laboratory of the St. Louis Water Dept. 2000 w. Jour Assn of Engng Socs—June, 1899. No. 28842 C.

Plant of the Maryland Cement Company, Sparrows Point, Maryland. Frederick H. Lewis. Illustrated description of a plant making hydraulic cement from blast-furnace slag. 1000 w. Eng Rec—July 15, 1899. No. 28595.

Cement Oven.

The Economical Value of the Rotary Cement Oven (Ueber den Oekonomischen Wert der Rotierenden Cement Brennofen). L. Tetmaier. A description of various types of rotary ovens, with discussions of the economy based upon various prices for labor and fuel. 2500 w. Schweizerische Bauzeitung—June 24, 1899. No. 28745 B.

Glass.

Experiments on the Strength of Glass (Recherches sur la Résistance Mécanique du Verre). A report of the tests of the resistance of glass to bending and tension, giving a very full report of the methods and results obtained by M. Grenet upon glass of the Saint-Gobain Works. 4000 w. Bull de la Soc d'Encour—June, 1899. No. 28711 G.

Iron Protection.

Paints for Iron. Gives results of ex-

periments made to determine the best paints and pigments for ironwork, and the most effective in preventing the corrosion under conditions of great severity, showing the superiority of paints containing red lead or orange lead. 1200 w. Engr, Lond—July 14, 1899. No. 28696 A.

Pipe Test.

Second Test of a 14-in. Riveted Steel Main at New Westminster, B. C. A. McL. Hawks. Description of test and report of results. 800 w. Eng News—July 6, 1899. No. 28453.

Testing Laboratory.

The Function of a Railroad Testing Laboratory. Samuel Stockton Voorhees. Brief summary showing its importance in selecting material that will give the greatest efficiency at the lowest cost. 1500 w. Jour Assn of Engng Socs—June, 1899. No. 28843 C.

Timber.

The Injection of Structural Timber With Antiseptics (Injection des Bois de Construction par les Antiseptiques). M. Karitschkoff. An account of the results of experiments made in Russia with the alkaline wastes from the petroleum refineries, for the preservation of railway sleepers and structural timber. 3000 w. Bull de la Soc d'Encour—June, 1899. No. 28712 G.

See Architectural Engineering, Miscellany.

MEASUREMENT.

Surveying Parties.

The Equipment of Camps and Expeditions. Charles H. Snow. Presented at New York meeting of the Am. Inst. of Min. Engs. Useful hints relating to transportation, food, packing, shelter, clothing, etc. 9000 w. Trans Am Inst of Min Engs—Feb., 1899. No. 28599 D.

MUNICIPAL.

Aqueduct.

The Washington Aqueduct, 1853-1898. William R. Hutton. Illustrates and describes engineering features of the work, including graphical analyses of the 220-ft. masonry arch over Cabin John Brook, and 120-ft. arch of unsupported cast-iron water mains. 5500 w. Eng Rec—July 29, 1899. No. 28837.

Association.

The Incorporated Association of Municipal and County Engineers. A statement of the organization and work in Great Britain of a unique society of engineers for municipal works. 2200 w. Eng Rec—July 22, 1899. No. 28681.

Bacteria.

The Practical Value of Bacteriological Examinations of Water. A. M. Bleile.

A criticism of bacteriological methods and a discussion of their value. 1500 w. Munic Engng—July, 1899. No. 28483 C.

Cleaning Pipe.

Cleaning Cast-Iron Water Pipe with Scrapers at St. John, N. B., and Boston, Mass. Condensed accounts of successful work in the places named. 1400 w. Eng News—July 20, 1899. No. 28679.

Disinfecting Station.

The Disinfecting Station at Genoa. James H. Fuertes. Illustrates a municipal station built to guard against contagious diseases. 1300 w. Eng Rec—July 22, 1899. No. 28684.

Drainage.

I. Ventilation of Sewers and Drains. R. Read. II. House Drainage. W. H. Savage. Two papers contributed to the Cardiff meeting of the Assn. of Munic. & Co. Engs., with discussion. 6300 w. Builder—July 8, 1899. No. 28622 A.

Dwellings.

The Hygiene of Dwelling Houses (Zur Hygiene des Wohnhauses). O. Richter. A general discussion of the structural features of dwelling houses, affecting their sanitary condition; including ventilation, drainage, etc., etc. 5000 w. Oesterr f d Oeffent Baudienst—July, 1899. No. 28736 D.

Filtration.

Test of a Mechanical Filter, East Providence, R. I. Gives the results of a run of several months under every day conditions of a filter of 500,000 gals. capacity. 1200 w. Eng Rec—July 1, 1899. No. 28442.

Test of Mechanical Filter at East Providence, R. I. Edmund B. Weston. Gives results that were obtained during a test of 110 days of a filter for the East Providence Water Co. 1000 w. Eng News—July 13, 1899. No. 28579.

The Biology of Sand Filtration. Ad. Kemna. Abstract of a paper read before the Engineering Conference of the Inst. of Civ. Engs., England, with discussion. Shows the progress and complications in sand filtration. 3800 w. Jour Gas Lgt—June 20, 1899. No. 28400 A.

Fire Protection.

Fire Protection for the District Below Chambers Street, New York City. Francis B. Stevens. Presents a plan modified to meet the changed conditions in this business portion of the city. 4500 w. Stevens Ind—July, 1899. No. 28827 D.

Garbage Fuel.

See Electrical Engineering, Generating Stations.

Paving.

Brick Paving in the Middle West. H.

Foster Bain. Discusses the suitability of the various paving materials for small towns in the locality named, especially noting the advantages from the introduction and wide use of brick paving. Ill. 2800 w. *Am Rev of Revs*—July, 1899. No. 28418 C.

Experience With Wood Pavements at Ipswich, England. Describes the foundations, character of blocks and wearing properties. 900 w. *Eng Rec*—July 1, 1899. No. 28444.

Redwood Block Paving with Asphalt Carpeting, at Oakland, Cal. From the report of M. K. Miller, Supt. of Streets. Describes the work of paving with redwood blocks with a thin asphalt carpet, giving particulars regarding the dipping and laying of the blocks. 1200 w. *Eng News*—July 20, 1899. No. 28680.

Refuse.

Experience in the Municipal Utilization of House Refuse (*Erfahrungen in der Stadtischen Hausmüllverwerthung*). Theodor Koller. Discussing the various methods of destroying refuse to the best advantage, with especial reference to the practice in the city of Munich, Bavaria. 2500 w. *Glaser's Annalen*—June 15, 1899. No. 28739 D.

The New Refuse Destructors in Berlin (*Der Neue Müllschmelzofen in Berlin*). W. Häntzschel. A description of the new Wegener refuse destructors now in use in Berlin. The furnaces are fed with powdered coal, and very successful results are reported. 2000 w. *Gesundheits-Ingenieur*—June 15, 1899. No. 28732 B.

Sewage Disposal.

A Federal Decision on Sewage Disposal Nuisances. Reviews the case of a resident of one state against a city in another, and gives the court's summary of the principles of law governing nuisances to private parties from public sewerage and drainage systems. 1700 w. *Eng Rec*—July 29, 1899. No. 28836.

A Sewage Distributing Tank and Automatic Dosing Apparatus for Marion, Ia. F. A. Barbour. Illustrates and describes the apparatus and gives an outline of the proposed plan of treatment. 2000 w. *Eng News*—July 13, 1899. No. 28578.

Bacterial Purification of Sewage. Samuel Rideal. This first of a series of lec-

tures reviews the use of cesspools, the effects of dilution, chemical precipitation, etc. 5300 w. *Jour Soc of Arts*—July 7, 1899. No. 28642 A.

Sewage Disposal at Brockton, Mass. Describes important practical studies on the effect of sedimentation of sewage before filtration. 2000 w. *Eng Rec*—July 8, 1899. No. 28514.

Sewerage.

The New Orleans Sewerage Ordinance. Describes the features of the ordinance under which the city proposes to spend many millions for drainage, sewerage and water-works. 1000 w. *Eng Rec*—July 15, 1899. No. 28594.

Sewers.

Sewers Laid Under Aqueducts at Newton, Mass. Henry D. Woods. Brief illustrated description of the work and statement of cost. 1100 w. *Jour Assn of Engng Socs*—May, 1899. No. 28401 C.

Street Improvement.

The Strand Improvement. Illustration of the proposed new route from Holborn to the Strand, with official description. 600 w. *Engr, Lond*—July 7, 1899. No. 28639 A.

MISCELLANY.

Address

Science and Engineering. W. H. Preece. Opening address of the president to the Engineering Conference, Institution of Civil Engineers, England. 2400 w. *Jour Soc of Arts*—June 23, 1899. No. 28423 A.

Early Engineering.

Early Engineering Work in the United States. Desmond Fitz Gerald. Address delivered at the annual convention of the Am. Soc. of Civ. Engs., at Cape May, N. J. Historical review of the earliest works and the men who designed and built them. 7500 w. *Eng News*—June 29, 1899. No. 28405.

Engineering.

The Pioneers of the Engineering Profession. Editorial giving an explanation of the slow progress of engineering in obtaining recognition. 1300 w. *Eng Rec*—July 1, 1899. No. 28440.

ELECTRICAL ENGINEERING

COMMUNICATION.

Africa.

The African Trans-Continental Telegraph Company. Details of the construction and working of the line to Nyassaland. Ill. 1700 w. *Elec, Lond*—July 7, 1899. No. 28616 A.

Duplex.

Duplex Telephony. Abstract of an article in the *Elektrotechnische Zeitschrift*, by Post-Inspector Schwensky. Reviews the progress of duplex working, illustrating various applications and giving a list of places where it is employed. 3000

w. Elect'n, Lond—July 14, 1899. No. 28808 A.

Rapid Telegraph.

High Speed Telegraph of Pollak and Virág (Schnelltelegraph von Pollak und Virág). A description of the system, and reproductions of messages sent at the rate of 100,000 words per hour. 3000 w. Elektrotech Zeitschr—July 6, 1899. No. 28768 B.

Pollak-Virág Machine Telegraph System. An illustrated description of a new invention remarkable for its extraordinary speed performance. 1400 w. Elec Wld & Elec Engr—July 15, 1899. No. 28572.

Space Telegraphy.

The Apparatus for Wireless Telegraphy. Jerome J. Green. Illustrates and describes the parts required for complete sending and receiving stations. 2300 w. Am Elect'n—July, 1899. No. 28495.

Telephone Construction.

Essentials of Telephone Construction. Maxime Reber. Read before the Independent Telephone Assn., Chicago. Discusses things required if the system is to give efficient service under all conditions. 3800 w. W Elect'n—July 1, 1899. No. 28464.

Telephones.

The Municipalization of the Telephone. A. B. Mountain. Read at the convention of the Municipal Electrical Assn., Bristol, England. Reviews efforts made to improve the telephone service in England, and endeavors to prove that if controlled by local authorities the rates can be reduced and the system developed. Discussion. 3300 w. Elec Eng, Lond—June 23, 1899. No. 28427 A.

See Railway Affairs, Permanent Way and Fixtures.

DISTRIBUTION.

Alternating Currents.

Notes on Distribution of Electricity. Charles D. Taite. Read before the Municipal Elec. Assn., England. Reviews recent changes in distribution, especially in alternating-current practice. Discussion. 3500 w. Elec Eng, Lond—June 24, 1899. No. 28428 A.

Philadelphia.

The Distribution of Electricity in Philadelphia. Gives the pole and wiring regulations of a city remarkable for its immunity from trouble with electrolysis. 1700 w. Eng Rec—July 22, 1899. No. 28687.

Protection.

The Protection of Low Tension Wiring Against Dangerous High Potential

Currents. W. J. Plews. Read before the Canadian Elec. Assn. Calls attention to the dangers due to a change in the system of secondary distribution, and considers apparatus to protect equipments. 900 w. Can Elec News—July, 1899. No. 28609.

The Protection of Secondary Circuits from Fire Risks. Cary T. Hutchinson. A paper presented at the Boston meeting of the Am. Inst. of Elec. Eng. A statement of the various possible consequences of a failure of insulation and the means of prevention. 3800 w. Elec, N. Y.—July 5, 1899. No. 28496.

Short-Distance.

Short Distance Electric Power Distribution. James Swinburne. A characteristic discussion of the defects of existing practice, and of the general expediency of electric driving as a substitute for other methods. 2500 w. Engineering Magazine—August, 1899. No. 28787 B.

Switchboards.

Electric Switchboards and Their Use. William Baxter, Jr. Illustrates and describes the various devices and explains their use. 2200 w. Am Mach—July 20, 1899. No. 28656.

Transformation.

Transformation from Three-Phase to Two-Phase Currents. P. G. Watmough. An illustrated explanation of the manner in which the change is effected. 700 w. Elec Wld & Elec Engr—July 22, 1899. No. 28661.

ELECTRO-CHEMISTRY.

Battery.

A New Primary Battery. J. D. Darling. Illustrates and describes the Harrison cell, the process of its manufacture, and the manner of overcoming galvanic polarization and local action. 2800 w. Jour Fr Inst—July, 1899. No. 28486 D.

Electric Energy.

On the Oxidation of Carbon at Ordinary Temperatures by Means of Atmospheric Oxygen with the Production of Electrical Energy. Willard E. Case. Presented before the Royal Society. Investigations in which ferric chloride was used as the carrier of oxygen. 4000 w. Elec Wld & Elec Engr—July 22, 1899. No. 28662.

Electrolysis.

Electrolysis at Places Apart from Electrodes. F. T. Trouton. A short account of experimental investigations showing that decomposition can take place at unsuspected places. 800 w. Elect'n, Lond—June 23, 1899. No. 28429 A.

Sterilisation.

The Industrial Sterilisation of Water

by Ozone (La Sterilisation Industrielle des Eaux Potables par l'Ozone). A discussion of the process of MM. Marmier and Abraham, reviewing the operation of the plant at Lille. 2500 w. *Revue Technique*—June 25, 1899. No. 28708 D.

ELECTRO-PHYSICS.

Coherers.

The Nature and Cause of the Phenomena in Coherers (Sur la Nature et la Cause du Phénomène des Cohéreurs). Thomas Tommasina. A note to the French Academy giving the results of the writer's investigations at the laboratory of the University at Geneva. 1200 w. *Comptes Rendus*—July 3, 1899. No. 28716 D.

Condensers.

Condensers. Harold B. Smith. Considers the various types. 1200 w. *Jour Worcester Poly Inst*—July, 1899. No. 28819 C.

Contact Maker.

A Simple Form of Instantaneous Contact Maker. Jonathan Haralson, Jr. Brief illustrated description of an instrument which has been in use in the electrical laboratory of the Alabama Polytechnic Inst. and has given satisfactory results. 450 w. *Elec Wld & Elec Engr*—July 15, 1899. No. 28571.

Electric Waves.

Reflection of Hertzian Waves at the Ends of Parallel Wires. Lee De Forest. Describes experimental investigations. 4000 w. *Am Jour of Sci*—July, 1899. No. 28422 D.

Velocity of Electric Waves in Air. G. V. Maclean. Briefly notes methods used by various experimenters, and describes an experiment in which a new method was employed, by which the direct determination of the period of the oscillator was found. 5400 w. *Am Jour of Sci*—July, 1899. No. 28420 D.

Velocity of Propagation of Electro-Magnetic Waves Through Air and Through Wires (Comparison des Vitesse de Propagation des Ondes Electro-Magnetiques dans l'Air et le Long des Fils). A communication to the French Academy by M. Gutton, describing the apparatus and method by which the tests were made, and showing the velocity to be alike in both cases. 1200 w. *Comptes Rendus*—June, 1899. No. 28714 D.

Interrupter.

A Modification of the Wehnelt Interrupter (Ueber eine Abänderung des Wehnelt'schen Stromunterbrechers). H. T. Simon. A claim that the improved interrupter described by Caldwell had been previously invented by the writer. 2000 w. *Elektrotech Zeitschr*—June 22, 1899. No. 28762 B.

An Improved Liquid Interrupter for Rhumkorf Coils. A. A. Campbell Swinton. Description with illustration. 500 w. *Elect'n, Lond*—June 30, 1899. No. 28544 A.

The Theory of the Wehnelt Interrupter (Beitrag zur Theorie des Wehnelt'schen Unterbrechers). Ernst Ruhmer. Notes of experiments made by the writer, confirming the theory of the generation and condensation of gas at the point of interruption. 2500 w. *Elektrotech Zeitschr*—June 29, 1899. No. 28765 B.

Wehnelt Interrupter Phenomena. Illustrates and describes experimental work conducted in the electrotherapeutic laboratory of the University of Michigan. 2300 w. *Elec Wld & Elec Engr*—July 29, 1899. No. 28832.

Magnets.

Steel for Magnets (Sur les Aciers à Aimants). A communication to the French Academy by M. Osmond, giving the results of investigations as to the influence of the chemical composition of steel upon its suitability for permanent magnets. 1000 w. *Comptes Rendus*—June 19, 1899. No. 28715 D.

Radiation.

Radiant Electric Forces. Alfred G. Dell. Deals briefly with some of the forces radiated from induction coils, and their discharges in vacuum tubes. 1500 w. *Elec Rev, N. Y.*—June 28, 1899. No. 28473.

GENERATING STATIONS.

Accounting.

Central Station Accounting from a Business Standpoint. P. H. Hart. Read before the Canadian Elec. Assn. Gives reasons why a standard system should be adopted, and describes a system which the author thinks can be readily put in operation by any company. 3800 w. *Can Elec News*—July, 1899. No. 28610.

Corporation Electricity Works Accounts. H. M. Stevens. Read at Plymouth meeting of the Corporate Treasurers' and Accountants' Inst. Reviews the form of accounts adopted by the British Board of Trade, discussing the arrangement, and the forms and books used in connection with the system, and related matters. 3800 w. *Elec Eng, Lond*—July 14, 1899. No. 28807 A.

Accumulators.

See Street and Electric Tramways.

Alternating Current.

Alternating-Current Generators and Transformers. Alton D. Adams. Illustrated detailed description of these machines and their operation. 9000 w. *Engr, U. S. A.*—July 1, 1899. No. 28465.

Ashton.

Ashton Corporation Electricity Works, and the Oldham, Ashton and Hyde Electric Tramway. Illustrates and describes an installation possessing features of interest. 4500 w. Elec Rev, Lond—July 14, 1899. No. 28806 A.

Condensers.

Condensers for Electric Light and Power Stations. J. F. C. Snell. Read at the Bristol convention of the Munic. Elec. Assn. Considers the advantages from the adoption of condensers, and the type to be selected, favoring surface condensers as a rule. Discussion. 6000 w. Elec Eng, Lond—June 30, 1899. No. 28545 A.

Garbage Fuel.

English Experience with Garbage as Fuel for Electric Light Stations. A. H. Campbell. Abstract of a paper presented at a recent meeting of the Munic. and Co. Engs., England. Indicates a belief in the possibilities of utilizing garbage for this purpose. 600 w. Eng News—July 13, 1899. No. 28575.

Isolated Plant.

The Lighting Plant at the Landonviller Castle near Metz (Beleuchtungsanlage des Schlosses Landonvillers bei Metz). G. Klingenberg. A description of a small isolated plant in which a water-power nearly a mile distant is utilized. 4000 w. Elektrotech Zeitschr—July 8, 1899. No. 28767 B.

Newington Vestry.

The Newington Vestry Electricity Works. Illustrated detailed description of the works. 2500 w. Elec Rev, Lond—June 23, 1899. No. 28430 A.

Paris.

The Electric Plant of the Paris Electric Cab Company (Usine Electrique de la Compagnie Générale des Voitures, à Paris). Showing the generating plant and the system adopted for charging the batteries. 2000 w. Revue Technique—June 25, 1899. No. 28707 D.

Park Row Building.

The Generating Plant, Distributing System and Transportation Facilities of the Highest Office Building in the World. Illustrated detailed description of these features of the Ivins Syndicate or Park Row Building of New York. 3300 w. Elec Wld & Elec Engr—July 1, 1899. Serial. 1st part. No. 28409.

Power Stations.

See Street and Electric Tramways.

Speed Regulation.

Elements of Design Favorable to Speed Regulation in Plants Driven by Water-Power. Allan V. Garratt. Presented at

the Boston meeting of the Am. Inst. of Elec. Engs. Describes those peculiarities of design which have a special bearing on speed regulation. Ill. 3000 w. Elec Rev, N. Y.—July 26, 1899. Serial. 1st part. No. 28814.

Statistics.

Statistics of Electric Plants in Germany (Statistik der Elektrizitätswerke in Deutschland). The annual tabulated statement of power and lighting plants in Germany, brought down to March, 1899, with editorial discussion. 15000 w. Elektrotech Zeitschr—July 8, 1899. No. 28766 B.

Taunton.

Taunton Electric Supply Works: Old and New. Illustrates and describes the present plant, and reviews the development since 1886. 1300 w. Elect'n, Lond—June 30, 1899. No. 28543 A.

Transformers.

Transformer Economy. F. H. Leonard, Jr. Read before the Can. Elec. Assn. On the practical use and high efficiency of the apparatus, and matters relating. 4000 w. Can Engr—July, 1899. Serial. 1st part. No. 28601.

HEATING AND WELDING.**Electric Heating.**

Electric Heating. Alton D. Adams. Discusses the energy from various heating devices, the cost, where electric heating can be used with advantage, etc. 1700 w. Sci Am—July 15, 1899. No. 28562.

LIGHTING.**Arc Lamps.**

The Siemens & Halske Hanging Lamp (Seillampe von Siemens & Halske A. G.). Görges and Queisser. A discussion of the comparative merits of the differential and the shunt lamp, with especial reference to the Siemens & Halske differential lamp. 6000 w. Elektrotech Zeitschr—June 22, 1899. No. 28763 B.

Charge System.

Wright's, or the Maximum Charge System for Electric Light. An explanation of this system, which is becoming widely adopted in England. 1800 w. Engr, Lond—June 30, 1899. No. 28557 A.

Hartford, Conn.

The Series Alternating Current Arc System in Hartford. Describes the extensions made and contemplated. Ill. 1500 w. Am Elect'n—July, 1899. No. 28494.

Illumination.

Distribution of Lights for Illumination. J. H. Kinealy. Part first discusses the things to be considered in designing a

lighting system, the standard of intensity, etc., giving opinions of writers on this subject. 2500 w. Heat & Ven—July, 1899. Serial. 1st part. No. 28812.

Regulation.

Arc Machine Regulation. H. Franklin Watts. Remarks on the systems of regulation employed, criticizing some of the regulators, and suggesting a remedy for their shortcomings. 1700 w. Elec Wld & Elec Engr—July 29, 1899. No. 28830.

Ship Lighting.

Suggestions for the Selection of Electric Lighting Sets for Ship Use. Alton D. Adams. Emphasizes durability and simplicity in design in selection of the plant, and gives valuable suggestions. 2800 w. Marine Engng—July, 1899. No. 28539 C.

MEASUREMENT.

Currents.

A Portable Apparatus for Photographing Curves of Two Variable Currents Simultaneously. Describes and illustrates the apparatus and its uses. 1600 w. Elec Wld & Elec Engr—July 22, 1899. No. 28663.

Frequency.

A Simple Method of Measuring the Duration of Period of an Alternating Current (Ueber eine Einfache Methode zur Messung der Periodendauer von Wechselströmen). Walter König. The measurement is made by the use of an electroscopic powder of sulphur and red lead, which, when shaken on a plate over which a wire carrying the current has been drawn, shows the positive and negative points. 1200 w. Elektrotech Zeitschr—June 15, 1899. No. 28758 B.

On a Method of Measuring the Frequency of Alternating Currents. Harrison W. Smith. Briefly describes a method recently employed for measuring variations in the frequency of currents of about 120 alternations per second. 1200 w. Tech Quar—June, 1899. No. 28524 E.

High Tension.

A New Laboratory Apparatus for the Production of High Tension Continuous Currents (Ueber einen Neuen Laboratoriumsapparat zur Erzeugung Hoher Gleichstromspannungen). L. Strasser. A number of secondary elements are used in connection with a rotary collector and commutator. 1200 w. Elektrotech Zeitschr—July 13, 1899. No. 28771 B.

Instruments.

Electric Measuring Instruments (Instruments de Mesures Electriques). Report of committee upon the instruments of MM. Chauvin and Arnoux, including

volt meters, ampere meters, recording galvanometers, resistance coils, etc., etc., with many illustrations. 7500 w. Bull de la Soc d'Encour—June, 1899. No. 28710 G.

Meters.

Meters and Meter Rates. A. A. Dion. A consideration of the importance of meters in connection with electric-light plants, discussing the desirable characteristics, testing, methods of charging, etc. 6500 w. Can Engr—July, 1899. No. 28600.

Methods.

Electrical Measurements. Henry A. Rowland and Thomas Dobbin Penniman. An account of experiments performed and methods used, with a method for the direct measurement of the effect of electric absorption in terms of resistance. 5800 w. Am Jour of Sci—July, 1899. No. 28421 D.

Permeameter.

Design, Construction and Test of a Special Type of Permeameter. R. R. Knowles and F. W. Putnam. Sketch of the instrument, with illustration. 1400 w. Jour Worcester Poly Inst—July, 1899. No. 28820 C.

Polyphase Testing.

Polyphase Electric Testing. Harris J. Ryan. Read at Boston meeting of the Am. Inst. of Elec. Engs. Treats of a method that employs a polyphase source for making instantaneous measurements of alternating currents or pressures without the use of a contact-maker. 2000 w. Elec Rev, N. Y.—July 5, 1899. No. 28530.

Standardization.

Electrical Standardization. Report adopted at the Boston meeting of the Am. Inst. of Elec. Engs. Part first gives the classification of apparatus. 1100 w. Elec Wld & Elec Engr—June 8, 1899. Serial. 1st part. No. 28525.

Synchronism.

Synchronism Indicator for Use with Parallel Alternating Currents (Einige Anordnungen von Synchronismusanzeigern zum Parallelschalten zweier Wechselstromquellen). Hermann Müller. A combination of a fixed and movable rotary field, with a pointer, the displacement of which indicates any departure from synchronism. 1800 w. Elektrotech Zeitschr—June 15, 1899. No. 28759 B.

Transformer Testing.

A Differential Method for Testing a Single Transformer. S. E. Johannesen. Describes a method devised by the writer, by which a single transformer may be tested under actual working loss condi-

tions with an energy consumption equivalent to the transformer losses alone. 1700 w. Elec Wld & Elec Engr—July 29, 1899. No. 28829.

Units.

On a Possible and Rational Simplification of Electric Units. A Blondel. On the desirability of promoting the practical use of the C. G. S. system, with suggestions. 2000 w. Elec Wld & Elec Engr—July 29, 1899. No. 28831.

POWER APPLICATIONS.

Electricity.

See Mining and Metallurgy, Mining.

Induction Motor.

Design for a One Horse-Power Two-Phase Induction Motor. Cecil P. Poole. Illustrated instructions for building such a motor. 2000 w. Power—July, 1899. No. 28413.

Machine Driving.

Independent Electric Driving (Elektrischen Einzelantrieb). O. Lasche. A discussion upon the relative advantages of continuous and polyphase currents for electric driving. 4500 w. Zeitschr d Ver Deutscher Ing—July 1. 1899. No. 28723 D.

Single Phase.

The Single Phase Induction Motor (Der Einphasen-Induktionsmotor). C. P. Steinmetz. With a mathematical analysis of the action, and curves to aid in design, and tables of constants. Two articles, 4500 w. Elektrotech Zeitschr—June 22, 29, 1899. No. 28761 each B.

TRANSMISSION.

Power Transmission.

Power Transmission by Direct and Alternating Currents. A criticism of Mr. Swinburne's results as given in the paper

presented at the Engineering Conference. The cases considered in the paper are worked out and the results given. 1100 w. Elec Rev, Lond—July 7, 1899. No. 28618 A.

Switzerland.

Legislation Concerning the Installation of High and Low Tension Electric Transmissions (Bundesgesetz betreffend die Elektrischen Schwach und Starkstromanlagen). With the full text of the recent Swiss law, based upon the report of an expert commission. 4000 w. Schweizerische Bauzeitung—June 30, 1899. No. 28746 B.

MISCELLANY.

Clocks.

The Electric Master Clock System in the City of Karlsruhe, Baden (Die Elektrische Centraluhrenanlage der Haupt und Residenzstadt Karlsruhe, i. B.). Emil Giehne. With illustrations of the master clock, and of the escapement used on the auxiliary dials. Serial, Part I. 1800 w. Elektrotech Zeitschr—July 13, 1899. No. 28772 B.

Cost.

Computations of the Cost of Alternating Currents (Berechnung des Strompreises bei Wechselströmen). G. Benischke. A discussion of a convenient method of computing current costs by the use of efficiency factors. 2000 w. Elektrotech Zeitschr—June 29, 1899. No. 28764 B.

Paris Exposition.

The Electrical Installation for the 1900 Paris Exposition. Georges Dary. Information concerning the buildings in which will be installed the electrical power appliances, and details of the electrical features. Ill. 3000 w. Elec Wld & Elec Engr—July 15, 1899. No. 28570.

GAS ENGINEERING

Acetylene.

The Calcium Carbide and Acetylene Gas Industries. John B. C. Kershaw. Cautionary remarks, giving information concerning the production and utilization. 2000 w. Elec Rev, Lond—July 7, 1899. No. 28620 A.

The Present Status of the Acetylene Industry (Ueber den jetzigen Stand der Acetylen-Technik). A general review of the various methods of generating acetylene now in use, together with the conditions of safe and economical use. Three articles. 3500 w. Schweizerische Bauzeitung—June 10, 17, 24, 1899. No. 28743 each B.

Bench Firing.

Isolated Generators for Bench Firing. Presented at Milwaukee meeting of the Western Gas Assn. Reports of Fred. Bredel, William Steinwedell, and Irwin Butterworth, with discussion. Ill. 7500 w. Pro Age—July 15, 1899. No. 28615.

Coke Oven Gas.

The Application of Coke-Oven Gas for Illuminating Purposes (Verwendung von Koksofengas zu Beleuchtungszwecken). With analyses of gases produced by various ovens, showing that a valuable excess of gas remains even after a portion is used for heating the ovens. 2000 w.

Stahl und Eisen—July 1, 1899. No. 28-750 D.

The Utilization of Coke-Oven Gas for Lighting. From *Stahl und Eisen*. Considers the causes of contamination in coke-oven gases, and the consequent inferior quality, and other subjects related which affect the economy. 1700 w. Col Guard—July 14, 1899. No. 28803 A.

Cyanides.

Cyanides in the Gas and Waste Products at Columbus O. E. E. Eysenbach. Read before the Western Gas Assn. Gives the results of quantitative determinations, and concludes that higher percentages are necessary before the cyanides can be extracted economically. Discussion. 1500 w. Am Gas Lgt Jour—July 3, 1899. No. 28472.

Distribution.

Distributing Gas Under Higher Pressure. F. H. Shelton. Read before the

Western Gas Assn., at Milwaukee. Considers whether it would not be of advantage to distribute gas at higher pressures than is common practice. Followed by general discussion. 7000 w. Am Gas Lgt Jour—July 17, 1899. No. 28611.

Foundations.

A Foundation That Failed and the Lesson It Taught. B. E. Chollar. Read before the Western Gas Assn. Explains the cause of unequal settlement which damaged a gasholder tank in St. Louis. Discussion. 2200 w. Am Gas Lgt Jour—July 3, 1899. No. 28471.

Mains.

Vitrified Clay Pipe Instead of Iron for Gas Mains. Irvin Butterworth. Read before the Western Gas Assn., at Milwaukee. Considers the properties that indicate the suitability of vitrified clay pipes for this use. Discussion. 3000 w. Am Gas Lgt Jour—July 17, 1899. No. 28612.

MARINE AND NAVAL ENGINEERING

Battleship.

Launch of the Battle-Ship "Kaiser Wilhelm der Grosse" (Stapellauf S. M. Linien-schiff "Kaiser Wilhelm der Grosse"). With reproductions of photographs of the vessel on the ways and in the water. A brief account of the launch and a description of the ship are given. 1000 w. Stahl und Eisen—July 1, 1899. No. 28-748 D.

Our Latest Battleship, the "Kearsarge." Brief illustrated account of the new American battleship and its armament. 1000 w. Sci Am—July 15, 1899. No. 28565.

The Canopus. Illustration with notes on some details not previously noticed. 600 w. Engr, Lond—July 14, 1899. No. 28698 A.

The Imperial Japanese Battleship "Hatsuse." Illustrated detailed description of this example of latest development in naval architecture. 1500 w. Engr, Lond—June 30, 1899. No. 28559 A.

The Launch of the Kaiser Wilhelm der Grosse. This vessel is one of a group of three turret ships building for Germany. Gives dimensions, illustrations and particulars. 600 w. Engr, Lond—July 7, 1899. No. 28637 A.

The United States Battleship "Maine." Illustration and description of this typical vessel of the three battleships recently ordered by the U. S. Congress. 1500 w. Engr, Lond—July 7, 1899. No. 28634 A.

Boilers.

Boilers for Torpedo Boats (Les Chau-

dières des Torpilleurs). A comparison between locomotive and water-tube boilers, with especial reference to the circular of the French Minister of Marine, regarding the requirements for the French service. 2000 w. Le Yacht—July 15, 1899. No. 28757 D.

Cold Storage.

U. S. Cold Storage Ship "Glacier." Gives a description of the vessel and its machinery, which takes cargo of frozen meat to Manila. 600 w. Ice & Refrig—July, 1899. No. 28487 C.

Cruisers.

Characteristics of the New Protected Cruisers of the Denver Class. Brief notes on the chief characteristics, dimensions and features of six new cruisers for the United States Navy. Ill. 900 w. Marine Engng—July, 1899. No. 28536 C.

H. M. SS. "Hermes" and "Highflyer." Engraving, with illustrations of the machinery of these second-class cruisers lately completed for the British navy, with description. 2000 w. Engng—July 7, 1899. No. 28624 A.

The Reconstructed Cruiser "Chicago." An illustrated account of the changes and improvements. 2500 w. Sci Am—July 15, 1899. No. 28564.

Destroyer.

Engines and Boiler; Japanese Torpedo-Boat Destroyer "Akebono." Illustrated description. 1000 w. Engng—June 30, 1899. No. 28550 A.

Germany.

The Development of German Shipbuilding. Rudolph Haack. The first of an important series of papers dealing with the enormous growth of shipbuilding in Germany since the consolidation of the empire in 1871. 3500 w. Engineering Magazine—August, 1899. No. 28780 B.

Losses.

From Furnace to Propeller—A History of the Energy Losses Which Occur on the Way. Edmund Leavenworth. Traces the losses, showing that only about 7.26 per cent. is utilized, and urging engineers to work for the decrease of losses. 3300 w. Marine Engng—July, 1899. No. 28537 C.

Merchant Marine.

The Rise and Fall of the American Merchant Marine. Joseph R. Oldham. Refers particularly to the foreign trade, considering some of the features that contributed to its decay, and claiming that the time is now ripe for its revival. Discussion. 6000 w. Jour Assn of Engng Socs—May, 1899. No. 28403 C.

River Steamer.

Record-Breaking Stern-Wheel Steamer "Hassalo" for Columbia River. Illustrates and describes a new river steamer built for the Oregon Railroad & Navigation Co. 1100 w. Marine Engng—July, 1899. No. 28538 C.

Salvage.

The S. S. Milwaukee. An account of an interesting and noteworthy feat of marine salvage and repair, with numerous illustrations. 600 w. Engr, Lond—June 30, 1899. No. 28558 A.

Shipbuilding.

Naval Architecture. Vernon D. Cox. From *The Independent*. Notes on the art and practice of shipbuilding. 1700 w. Sci Am Sup—July 8, 1899. No. 28450.

The Stettiner Maschinenbau Actien-Gesellschaft "Vulcan." Interesting information concerning the Vulcan Works at Bredow, near Stettin, Germany, the great progress, especially during the last ten years, giving diagrammatic profiles of work done. The success of the twin-screw Atlantic liner "Kaiser Wilhelm der Grosse," and comparison with other ves-

sels. 3800 w. Engng—July 7, 1899. Serial. 1st part. No. 28623 A.

Ship Lighting.

See Electrical Engineering, Illumination.

Shipyard.

Model American Shipyard. Illustrates and describes the plant of the Harlan & Hollingsworth Co., of Wilmington, Del., its equipment and operation. 3300 w. Marine Rev—July 13, 1899. No. 28604.

Steamboats.

Some Early Thames Steamboats. An account of these boats and their work, dating back to 1815. 2400 w. Engr, Lond—July 7, 1899. No. 28638 A.

Testing Tank.

The Navy's New Experimental Tank. Description of the new basin at the Washington navy yard, which will be used for the purpose of experimenting with warship models. 3000 w. Naut Gaz—July 13, 1899. No. 28603.

The New Government Testing Tank for Ship Models at the Washington Navy Yard. D. W. Taylor. An interesting illustrated account of basin at the Washington navy yard, the method of building the models, and conducting the experiments, etc. 3000 w. Eng News—July 6, 1899. No. 28451.

The United States Experimental Model Basin. An illustrated description of the experimental basin at the Washington navy yard, recently completed. 3500 w. Sci Am—July 8, 1899. No. 28448.

The U. S. Navy Experimental Model Basin. An illustrated description of the testing tank at Washington, D. C., with a description also of the apparatus and method of experimenting. 2800 w. Am Mach—July 6, 1899. No. 28461.

Yacht.

Cup Defender Columbia. Illustration with description of this recently completed racing craft, which is representative of the latest developments in yacht construction. 1500 w. Marine Rev—June 29, 1899. No. 28468.

The Columbia. Particulars and features of the new cup defender, with brief history of the cup races. Ill. 1700 w. Naut Gaz—July 6, 1899. No. 28531.

MECHANICAL ENGINEERING

AUTOMOBILISM.

Association.

A National Automobile Association. An editorial calling attention to features of the situation which make the organization of such a body desirable. 1000 w.

Elec Rev, N. Y.—July 19, 1899. No. 28649.

A National Automobile Association. Editorial suggesting the organization of such an association. 400 w. Elec Rev, N. Y.—July 12, 1899. No. 28648.

Competition.

The Second Competition of Automobile Cabs (Deuxième Concours des Fiacres Automobiles). With descriptions of the competing vehicles, and a summary of the results of the trials. 4000 w. Génie Civil—June 24, 1899. No. 28703 D.

Electric Vehicles.

Electric Automobiles. Elmer A. Sperry. Read at Boston meeting of the Am. Inst. of Elec. Eng. Discusses types of batteries, tires, problems to be solved by designers, etc. 3900 w. Elec, N. Y.—July 19, 1899. No. 28650.

Riker's Electric Wagons. Hugh Dolnar. Working drawings showing the principal mechanical inventions in motor wagons made by this establishment, with explanation of methods. 2200 w. Am Mach—July 13, 1899. No. 28584.

Fire Wagon.

An Electric Fire Wagon. Illustrates and describes a vehicle with electrical equipment, designed for the Paris Fire Brigade, and reports highly encouraging experimental trials. 1200 w. Engr, Lond—July 7, 1899. No. 28641 A.

Motor Cycles.

The Bicycle as a Motor Vehicle (Das Fahrrad als Droschke). K. Hallbauer. With numerous illustrations showing motor vehicles designed on the lines of the bicycle and tricycle, and adapted for delivery vehicles and general use. 1200 w. Glaser's Annalen—June 15, 1899. No. 28738 D.

Motor Vehicles.

Early Motor Vehicles and Modern Practice. Illustrated notes of early steam carriages. 1700 w. Automotor Jour—June, 1899. No. 28408 A.

Operating Cost.

Operating Cost of Horse and Electric Delivery Wagons in New York City. Abstract of a paper read at the meeting of the Am. Inst. of Elec. Eng. Comparison of cost of operating in favor of the electric vehicles, with statement of advantages. 4500 w. Elec Wld & Elec Engr—July 8, 1899. No. 28526.

Paris.

Motor Cars in Paris. Comments on the vehicles at the late exhibition, the lack of novelty, but evidences of improvement, the power used, etc. 2200 w. Engr, Lond—July 14, 1899. No. 28800 A.

Steam Motor-Cars.

Some American Steam-Driven Motor Vehicles. Horace L. Arnold. Illustrates and describes four vehicles made in or near Boston, which collectively exhibit all the features of an ideal automobile.

2000 w. Ind & Ir—June 30, 1899. Serial. 1st part. No. 28547 A.

HYDRAULICS.**Hydraulic Plant.**

The East Jersey Water Company's Hydraulic Plant at Little Falls, N. J. Illustrated description of a station designed to have an ultimate capacity of 120,000,000 gals. daily, and fitted with turbines and power pumps designed by Prof. A. Riedler. 2000 w. Eng Rec—July 8, 1899. No. 28515.

Niagara.

The Utilization of Niagara Falls (Utilisation des Chutes du Niagara). Georges Henry. A description of the extension of the Niagara power plant, with numerous illustrations and a plate of details of the turbines. 3500 w. 1 plate. Génie Civil—June 17, 1899. No. 28700 D.

Pumping.

Pumping Engines Driven by Water Power. Charles A. Hague. The article is confined to pumping engines wherein the pinion shaft is driven by gears from a turbine shaft. 2000 w. Eng News—July 6, 1899. No. 28455.

Triple Expansion Pumping Engine for the Cleveland, O., Water Works. Illustrates and describes the new 20,000,000 gallon engine recently erected. It is of the vertical triple-expansion type. 1200 w. Power—July, 1899. No. 28412.

See Mining and Metallurgy, Mining.

Speed Regulation.

See Electrical Engineering, Generating Stations.

MACHINE WORKS AND FOUNDRIES.**Band-Sawing.**

Band-Sawing a Bevel Pinion. W. H. Freeman. Illustrated description of the method used. 1200 w. Am Mach—July 20, 1899. No. 28657.

Bolt Heads.

Report on Comparative Test of Bolt Heads. W. Kendrick Hatt. Explains the purpose of the tests, and their results, with discussion. Presented at the Convention of the Master Car Builders' Assn. 2700 w. R R Car Jour—July, 1899. No. 28490.

Castings.

Pig Iron for Malleable Castings. C. E. Wheeler. Deductions gathered from experience concerning heat influences, silicon, sulphur and phosphorus. 3800 w. Ir Trd Rev—July 13, 1899. No. 28568.

The Warping of Castings and the Remedy. R. D. Moore. Suggestions for the prevention of warping and for straightening. 1500 w. Am. Mach—July 13, 1899. No. 28586.

Cast-Iron Pipes.

The Manufacture and Inspection of Cast-Iron Pipes. Thomas H. Wiggin. An illustrated description of the process of pipe making and inspecting, giving tests and conclusions. 21000 w. Jour Assn of Engng Socs—May, 1899. No. 28402 C.

Dies.

Die Construction. George B. Painter. Illustrates a die for shearing and drawing a piece of sheet metal into the form of a cup with irregular edges. 700 w. Am Mach—July 20, 1899. No. 28658.

Drills.

Setting Diamond Drill Bits. Practical instructions, with illustrations, prepared by J. Parke Channing and published by the Sullivan Machinery Co. 900 w. Eng & Min Jour—July 15, 1899. No. 28605.

Forging Press.

A Great Forging Press (Grosse Schmiedepressen). An illustrated description of the 10,000 ton hydraulic forging press recently built by Breuer, Schumacher & Co. for the Dillingen Iron Works, Germany. 1000 w. 2 plates. Stahl und Eisen—July 1, 1899. No. 28749 D.

Foundry Practice.

Latter Day Foundry Progress. Translation and comment by Dr. Richard Moltenke, of Prof. A. Ledebur's review of the development of foundry practice during the last half of the 19th century, as published in the *Zeitschrift des Vereins Deutscher Ingenieure*. 3000 w. Ir Trd Rev—June 29, 1899. No. 28411.

Iron Mixtures.

Governing Mixtures by Silicon. A contribution to the discussion of a paper by Bertrand S. Summers, read at the Buffalo meeting of the Am. Inst. of Min. Engrs. 4000 w. Ir Trd Rev—July 13, 1899. No. 28569.

Iron Works.

See Mining and Metallurgy, Iron and Steel.

Machine Tools.

Machine Tools to Be Installed in the New Building at New York Navy Yard. A complete list. 800 w. Am Mach—July 20, 1899. No. 28655.

Match Works.

The Works of the Diamond Match Company, Limited. Illustrated detailed description. 2500 w. Engr, Lond—July 7, 1899. Serial. 1st part. No. 28636 A.

Power Shear.

A Power Shear With a Peculiar Movement. Illustrated description. 600 w. Am Mach—July 6, 1899. No. 28459.

Precision Lathe.

Some of the Products of Professor W. A. Rogers' Precision Lathe. An illustrated description of some of the more important pieces of work done on the lathe before its destruction by fire. 2200 w. Am Mach—July 27, 1899. Serial. 1st part. No. 28816.

Premium Plan.

The Administration of the Premium Plan. F. A. Halsey. The purpose of the article is to show just how the plan is carried out in some of the shops where it is used. 1800 w. Am Mach—July 6, 1899. Serial. 1st part. No. 28460.

Repairing.

Machinery Repairing. F. A. Farnsworth. Gives suggestions for tempering, case-hardening, etc. Ill. 1000 w. Engr, U. S. A.—July 1, 1899. No. 28467.

Special Tools.

Special Tools for Setting and Holding Work. H. S. Brown. Brief description of useful tools. Ill. 1400 w. Am Mach—July 6, 1899. No. 28462.

Springs.

Some Constants for Use in Designing Elliptic Springs. F. F. Gaines. Gives constants which have proven their correctness and value. 1000 w. Am Mach—July 20, 1899. No. 28660.

Steel Bin.

A Novel Design for a Steel Bin for the Storage of Coal, Grain, Sand or Cement. A. S. Berquist. Illustrates and describes the construction of a bin erected for the American Coffee Co., of Brooklyn, N. Y. 1200 w. Eng News—July 27, 1899. No. 28834.

Tools.

Crank-Hanger Jigs and Tools. A. H. Cleaves. Illustrated descriptions. 600 w. Am Mach—July 13, 1899. No. 28585.

Machine Tools, with Special Reference to American and German Practice as Compared with English. Arthur Greenwood. Read before the Engng. Conference of the Inst. of Civ. Engrs., England. Discusses the tools under four classes—planing machines, lathes, milling machines and automatic. Discussion. 3800 w. Engr, Lond—April 23, 1899. No. 28434 A.

Tubing.

The Production of Seamless Tubing. H. S. Wilson. Describes the oldest methods and traces the various changes which have led to modern practice. Ill. 4900 w. Jour Assn of Engng Socs—June, 1899. No. 28841 C.

Wire Works.

The British Insulated Wire Company's

Works at Prescott. Illustrated description of the works and the process by which the cables are manufactured. 3000 w. *Elect'n*, Lond—July 7, 1899. No. 28-644 A.

Works Management.

Machine Shop Management in Europe and America. H. F. L. Orcutt. The conclusion of Mr. Orcutt's notable series of papers, giving his final opinions as to the details of a standard shop design. 3000 w. *Engineering Magazine*—August, 1899. No. 28781 B.

MATERIALS OF CONSTRUCTION.

Expansion.

The Expansion of Metallic Alloys (*Sur la Dilatation des Alliages Metal-liqués*). H. Le Chatelier. A communication to the French Academy discussing especially the behaviour of alloys of copper and antimony, and copper and aluminum, with curves showing the relation of expansion to the percentage of copper present. 1200 w. *Comptes Rendus*—June 12, 1899. No. 28713 D.

Torsion Testing.

An Inexpensive Autographic Torsion Testing Apparatus. Robert A. Bruce. Illustrates and describes a design and the method of operating it. 1200 w. *Am Mach*—July 20, 1899. No. 28659.

POWER AND TRANSMISSION.

Air Transmission.

The Friction of Compressed Air in Pipes. J. E. Johnson, Jr. Gives diagrams for facilitating calculations, and explains the cause of inaccuracy in formulas. 2500 w. *Am Mach*—July 27, 1899. No. 28817.

Crane Driving.

Cranes and the Power to Be Used with Them. Mr. Pitt. Read before the Engng. Conference of the Inst. of Civ. Engs., England. Considers self-contained cranes carrying their own motive power, and cranes actuated by power from a separate generator. Discussion. 2700 w. *Engr*, Lond—June 28, 1899. No. 28435 A.

SPECIAL MOTORS.

Petroleum.

Evolution and Future of Benzine and Petroleum Motors. Georg Lieckfeld. Herr Lieckfeld's second paper shows the evolution of the petroleum motor from the gas engine, and discusses the lines along which it promises to become the motor of the future. 3000 w. *Engineering Magazine*—August, 1899. No. 28786 B.

Improvements in Four-stroke Petroleum Motors During the Past Ten Years

(Verbesserungen des Viertakt Petroleum-motors in den Letzen 10 Jahren). Fr. Dopp, jun. A general review of the development of the petroleum motor, with especial reference to the engine designed by the writer. 4000 w. *Zeitschr d Ver Deutscher Ing*—June 24, 1899. No. 28-719 D.

STEAM ENGINEERING.

Boilers.

See Marine and Naval Engineering.

Condensing.

Separate Condensing Plants for Factory Purposes. Alfred Seale Haslam. Read before the Engng. Conference of the Inst. of Civ. Engs., England. Briefly considers the four classes into which the author divides condensers. 2500 w. *Engs' Gaz*—July, 1899. No. 28587 A.

Connecting Rod.

The Geometric Determination of the Resultant of the External Forces Acting Upon a Connecting Rod (*Die Geometrische Bestimmung der Resultaten der auf eine Schubstange Wirkenden Aussenen Kräfte*). Prof. Mohr. Giving a simple graphical construction and diagrams showing its application. 1000 w. *Zeitschr d Ver Deutscher Ing*—July 8, 1899. No. 28725 D.

Cooling Tower.

The Theoretical Treatment of Air Cooling Water Towers. William A. Moss crop. States the problem to be solved, and illustrates the possibilities of formulas given. 1200 w. *Eng News*—July 13, 1899. No. 28576.

Feed Water.

Recent Practice in Purifying Feed Water for Locomotives. A summary of the committee report to the Mas. Mechs. Assn., dealing with purification by chemicals, and the treatment of water at pumping stations. 4000 w. *Eng News*—June 29, 1899. No. 28407

Fire Box.

Corrugated Fire-Box Sheets for Locomotive Boilers. R. J. O'Neil. From the *Boiler Maker*. Illustrates the method of cupping fire-box sheets used by the Chicago and Alton Ry. 600 w. *Eng News*—July 13, 1899. No. 28577.

Firing.

See Railway Affairs, Motive Power.

Fuel.

The Economical Use of Fuel. From the presidential address of Mr. George Beilby before the Soc. of Chem. Ind. Shows the magnitude of the problem and discusses the remedies. 1200 w. *Col Guard*—July 14, 1899. No. 28802 A.

Governors.

The Dynamics of Direct and Continuous-Acting Governors (Dynamik Direct und Continuirlich-Wirkender Regulator-en). C. Koerner. An elaborate mathematical discussion, giving equations for various conditions, and curves showing the governing action. Three articles, 7500 w. Zeitschr d Oesterr Ing u Arch Ver—June 30, July 7, 14, 1899. No. 28-729 each B.

Heat Absorption.

The Heat-Absorption Power of Water. G. Halliday. On the circulation in the tubes of water-tube boilers; giving results of experiments. 2000 w. Engr, Lond—July 7, 1899. No. 28640 A.

Heat Exchanges.

Recent Researches Upon the Heat Exchanges Between the Steam and Cylinder-Walls (Der Wärmeaustausch zwischen Dampf und Cylinderwandung nach Neuren Versuchen). A. Bautlin. An elaborate review of the experiments made several years ago by Messrs. Nicolson and Callendar at Montreal. Serial. Part I. 4000 w. Zeitschr d Ver Deutscher Ing—July 1, 1899. No. 28721 D.

Indicator Cards.

See Railway Affairs, Motive Power.

Locomotive Boilers.

See Railway Affairs, Motive Power.

Portable Engines.

Some Trials of Portable Engines. Describes trials carried out on what was practically the same engine under three different conditions and under three different loads, giving results. 5000 w. Mech Wld—June 23, 1899. No. 28425 A.

Purifier.

A New Water-Purifier for the Prevention of Boiler Scale (Ein Neuer Wasserreiniger zur Vollständigen Vermeidung von Kesselstein). Franz Walter. An illustrated description of the Grevenbroich filtering apparatus for boiler feed-water. 2000 w. Oesterr Monatschr f d Oeffent Baudienst—July, 1899. No. 28735 D.

Shocks.

The Action of Shocks in Steam Engines (Stösse und Momente in Dampfmaschinen). J. Meifort. A discussion of the inertia of the reciprocating parts in steam engines, with especial reference to the reduction of vibration in multiple cylinder marine engines. 2500 w. Zeitschr d Ver Deutscher Ing—July 8, 1899. No. 28726 D.

Smoke Prevention.

The Smoke Prevention Legislation in Berlin (Das Bevorstehende Verbot des Schornsteinrauchens in Berlin). W.

Häntzschel. A discussion of the proposed legislation by which the production of smoke from chimneys in Berlin is forbidden. 1800 w. Gesundheits-Ingenieur—June 30, 1899. No. 28733 B.

Stay Bolts.

Best Method of Applying Stay Bolts to Locomotive Boilers. Abstract of committee report presented at the annual convention of the Mas. Mechs. Assn. Ill. 2200 w. Eng News—June 29, 1899. No. 28406.

Steam Conduits.

See Architectural Engineering, Heating.

Steam Fittings.

The Arrangement of Steam and Other Pipes and Their Fittings. J. E. Edgcome. Read at the Bristol Convention of the Munic. Elec. Assn. Information from experience, relating to the arrangement of piping for small or moderate sized stations. Ill. 4000 w. Elec Eng, Lond—June 30, 1899. No. 28546 A.

Valve Gear.

Corliss Valves and Gears. The first of a series of articles considering the proportions of Corliss valves, the action of the wrist-plate on the valve movement, etc. Ill. 800 w. Mech Wld—July 7, 1899. Serial. 1st part. No. 28645 A.

Valve Setting.

Setting the Valves of the Buckeye and Rollins Engines. H. H. Kelley. Illustrates and describes the construction giving directions. 2300 w. Engr, U. S. A.—July 15, 1899. No. 28647.

Valves.

An Adjustable Valve Model. Illustrates and describes a locomotive valve model that can be adjusted to the exact size of the valve motion of most any ordinary locomotive. 2200 w. Ry & Engng Rev—July 15, 1899. No. 28613.

MISCELLANY.**Bicycles.**

Bicycle Chains. George H. Waltman. Gives illustrated description of the different chains, and their strength as determined by experiment. 1800 w. Mach, N. Y.—July, 1899. No. 28414.

Compressed Air.

Mechanical Applications of Compressed Air. W. L. Saunders. Considers some of the practical applications, its importance in bridge construction, its applications in connection with railroads, etc. Ill. 2000 w. Jour Fr Inst—July, 1899. Serial. 1st part. No. 28485 D.

Compressor.

An Unusual Compressor. Walter K.

Edgar. A criticism of Mr. Wakeman's article on "Operating Ice Machines." 1300 w. Ice & Refrig—July, 1899. No. 28488 C.

Liquid Air.

The Cost of Liquid Air. Frank Richards. Showing that the cost of liquid air is about 5 cts. a gallon as now produced. 1200 w. Am Mach—July 27, 1889. No. 28815.

The Latest Liquid Air Plant. W. C. Peckham. An illustrated description of the interesting plant of the General Liquid Air and Refrigerating Co., of New York, with account of tests. 2500 w. Sci Am—July 15, 1899. No. 28563.

Refrigeration.

Refrigeration in the Brewery. A. F. McClatchey. Describes the process of beer making and the coolers and cooling arrangements. 2500 w. Ice & Refrig—July, 1899. No. 28489 C.

Ventilators.

Helicoidal Ventilators (Ventilateurs Helicoïdes). A. Laponche. A discussion of exhaust fans and ventilating wheels of the turbine form, together with methods of driving by electricity and steam. 2500 w. Génie Civil—June 17, 1899. No. 28701 D.

Waste.

The Utilization of Waste. John Birkinbine. On the importance of utilizing waste products in the industries, noting some applications. Discussion. 3200 w. Pro Eng's Club of Phila—July, 1899. No. 28825 D.

Wire Gun.

The Brown Segmental Tube Wire Gun. Edward A. Gage. Briefly reviews the history of wire-wound guns, and describes the invention of J. H. Brown, and its construction. 4000 w. Jour Worcester Poly Inst—July, 1899. No. 28818 C.

MINING AND METALLURGY

COAL AND COKE.

British Columbia.

Coal Mining in British Columbia. Harrison F. Bulman. Describes the collieries of Crow's Nest Pass and Vancouver Island. 3500 w. Col Guard—June 30, 1899. No. 28555 A.

Cape Colony.

At a Cape Colonial Coal Mine. A statement of the conditions found by the writer at Indwe, in the northeastern portion of the colony. 2300 w. Col Guard—July 7, 1899. No. 28629 A.

Coal Fields.

Coal Fields of Colorado. Arthur Lakes. A description of the different deposits and a consideration of the causes which operated to vary the qualities in different areas. 3300 w. Mines & Min—July, 1899. No. 28506 C.

Some Coal Fields of Puget Sound. Bailey Willis. From the annual report of the U. S. Geol. Survey. Part first considers the location and formation. 1500 w. Ind & Ir—July 7, 1899. Serial. 1st part. No. 28627 A.

The Great Northern Coal Field—Its Rise and Progress. Reviews the history of the collieries in the north of England. Maps. 3700 w. Ir & Coal Trds Rev—July 14, 1899. No. 28804 A.

Coal Sales.

Coal Sales and Contracts. George Johnson. Gives the form of declaration and method of charging for coal con-

veyed by rail in England. 2000 w. Col Guard—June 23, 1899. No. 28438 A.

Coal Wagons.

Coal Wagon Estimates and Costs. George Johnson. Suggestions to colliery owners who are to build their own wagons. 2000 w. Col Guard—July 7, 1899. No. 28628 A.

Coal Washing.

The Rhymney Coal-Washing Plant. Illustrates and describes a large washing plant recently erected in England. 2700 w. Ir & Coal Trds Rev—June 23, 1899. No. 28431 A.

Coke Furnace.

An Improved Muffle Furnace for Burning Coke. T. Graham Martyn. Read before the Inst. of Min. & Met., London. Longitudinal and transverse sections are given with description and statement of advantages secured. 900 w. Col Guard—June 30, 1899. No. 28552 A.

New Zealand.

Coal Outcrops at the Tangarakau River. Alexander McKay. Report on the district between Stratford and the river named. 1500 w. N. Z. Mines Rec—May 16, 1899. No. 28458 B.

COPPER.

Australia.

Australian Copper. Editorial comment on the boom in copper and its effect on copper mining, especially considering the deposits in Australia. 2500 w. Engng—July 7, 1899. No. 28626 A.

Copper Industry.

The Copper Supply. Editorial review of the copper situation. 1500 w. *Ir Age*—July 20, 1899. No. 28654.

Ores.

Copper Ores. Arthur Lakes. Description of some of the copper regions of North America, considering the mode of occurrence and the peculiarities of the ores of different mines. 2600 w. *Mines & Min*—July, 1899. No. 28610 C.

GOLD AND SILVER.**Assaying.**

Assaying Telluride Ores for Gold. Richard W. Lodge. Describes experiments with scorification and crucible methods, illustrating points of interest to assayers. 900 w. *Tech Quar*—June, 1899. No. 28523 E.

British Columbia.

Leech River, Alberni and Skirt Mountain. W. M. Brewer. Report of the camps named. 1600 w. *Eng & Min Jour*—July 8, 1899. No. 28528.

Colorado.

Resources of the Mount Wilson District, Colorado. Frank L. Nason. An illustrated account of this region very favorable to the advisability of investing, and explaining the conditions to be met. 2300 w. *Eng & Min Jour*—July 22, 1899. No. 28689.

Copper Plates.

Amalgamated Copper Plates. N. S. Keith. Describes a plan of preparation and treatment that has been found effective and inexpensive as compared with silver plating. 2300 w. *Min & Sci Pr*—July 1, 1899. No. 28463.

Cyanide.

Notes on the Estimation of Protective Alkali in Cyanide Solutions. Andrew F. Crosse. Describes experiments and the writer's method of determining protective alkali. 1200 w. *Jour of Chem & Met Soc of S Africa*—May, 1899. No. 28540 E.

Dredging.

Gold Dredging in California. R. H. Postlethwaite. Information of the work in the Feather River, near Oroville, Cal. 1400 w. *Min & Sci Pr*—July 8, 1899. No. 28566.

Gold Dredging. John M. Sweeney. Illustrated description of devices for obtaining gold from placer deposits with a limited water supply, giving results of experiments and practical trials. 3800 w. *Mines & Min*—July, 1899. No. 28503 C.

French Guiana.

Gold Mining in French Guiana. E. D.

Levat. An account of the prospecting method of working, and peculiarities of the native workers. 1600 w. *Eng & Min Jour*—July 8, 1899. Serial. 1st part. No. 28529.

Gold Mining.

Fine Gold Mining and Concentration. N. J. Fleck. On the excellent work accomplished with the river burlap machine. 1200 w. *Eng & Min Jour*—July 15, 1899. No. 28607.

Independence Mine.

How the Independence Mine Was Discovered. T. A. Rickard. An account of the discovery of one of the most valuable gold mines ever uncovered. 1300 w. *Eng & Min Jour*—July 15, 1899. No. 28606.

Klondike.

The Engineer and the Road to the Gold Fields. Harrington Emerson. A graphic account of the opening of the Yukon and White Pass Route to the Klondike, with many illustrations of the difficult engineering work involved in the construction of the railway. 5000 w. *Engineering Magazine*—August, 1899. No. 28782 B.

Mexico.

The Mining Camps of El Oro, Mexico. Robert S. Barrett. A descriptive account of a camp which the writer believes is destined to become one of the greatest gold mining camps of the world. 1200 w. *Eng & Min Jour*—July 22, 1899. No. 28690.

Ore Treatment.

Problems in the Treatment of Butte Ores. A. H. Wethey. Experiments led to the decision to put in a Chilson mill, and grind the jig tailings, treating the re-ground material on Wilfley machines. These machines are illustrated. 1200 w. *Eng & Min Jour*—July 1, 1899. No. 28475.

Philippines.

Gold in the Philippines. Ramon Reyes. Lala. A brief account of what is thus far known of gold in the Philippines, and the primitive methods used by the natives in its mining and extraction. 2200 w. *Am Rev of Revs*—July, 1899. No. 28419 C.

Placer Gold.

Gold-Bearing Gravels of the West. Condensed from paper by Alexander McDougall. Illustrates and describes the McDougall plant for placer mining. 1400 w. *Min & Sci Pr*—July 15, 1899. No. 28666.

Pockets.

Origin and Age of Certain Gold "Pocket" Deposits in Northern California. O. H. Hershey. A statement of what the author considers the corre-

theory of the mode of formation. 2000 w. *Am Geol*—July, 1899. No. 28560 D.

Sampling.

Sampling Placer Deposits. Edmund B. Kirby. Read before the Colorado Scientific Society. On the importance of correct methods of testing their value. 3800 w. *Mines & Min*—July, 1899. No. 28508 C.

Silver Lead.

The Silver-Lead Deposits of the Slokan, British Columbia. J. D. Kendall. Read before the Inst. of Min. & Met. An interesting illustrated account of this district, which promises to be one of the most important producers of silver-lead ore in the world. 9500 w. *Can Min Rev*—June 30, 1899. No. 28424 B.

Slimes.

A Continuous Process of Slimes Treatment. Ernest T. Rand. Describes the process and gives some practical results. Ill. 2200 w. *Jour of Chem & Met Soc of S. Africa*—May, 1899. No. 28541 E.

Transvaal.

The Transvaal Mines and the Boer Government. F. H. Hatch. A timely discussion of the relations of the actual conditions on the Rand, with the engineer's interest in reforms. 2500 w. *Engineering Magazine*—August, 1899. No. 28785 B.

IRON AND STEEL.

Blast Furnaces.

Blast-Furnace Reactions. Translated from the French of M. E. de Billy. Discusses the action of manganese, silicon, sulphur, phosphorus, arsenic, lead, zinc, copper, etc., in the furnace. 3000 w. *Mines & Min*—July, 1899. No. 28509 C.

Ingot.

Mold for Steel Ingot. Henry L. Gantt. Specification descriptive of an invention to prevent the ingots from cracking along the surface. Ill. 1600 w. *Am Mfr & Ir Wld*—July 13, 1899. No. 28602.

Iron Ores.

The Iron Ores of the West Coast. Reviews the history of the ores of the west coast of England, the deposits, cost of production, etc. 1500 w. *Ir & Coal Trds Rev*—July 14, 1899. No. 28805 A.

Iron Works.

The "Deutscher Kaiser" Company's Iron Works. From *Stahl und Eisen*. Illustrates and describes this recent and extensive construction. 1000 w. *Ir & Coal Trds Rev*—June 30, 1899. No. 28549 A.

The "Deutscher Kaiser" Iron Works at Bruckhausen on the Rhine (*Gewerkschaft "Deutscher Kaiser" in Bruckhaus-*

sen am Rhein). A general description of this large new works in the Westphalia district with views of the furnaces, and elevation and details of compound blowing engines. 2500 w. 1 plate. *Stahl und Eisen*—June 15, 1899. No. 28747 D.

MINING.

China.

Mining in Szechuan. A copy of the regulations for the working of mines in this province. 3300 w. *U. S. Cons Repts*, No. 471—July 8, 1899. No. 28567 D.

Conductors.

Wire Rope Conductors for Pit Cages. John Vaughan. Read before the South Wales Inst. of Eng. Considers this type of conductor exclusively, the difficulties and disturbing elements to be avoided in laying down the plant, manner of putting the ropes into position, etc. Ill. 3000 w. *Col Guard*—June 30, 1899. No. 28556 A.

Cooling.

Methods of Cooling Overheated Workings in Mines (*Vorschläge zur Abkühlung Warmer Betriebspunkte in Grubenbauen*). Dr. Tübben. Reviewing the present methods of cooling by sprinkling and by the expansion of compressed air, and suggesting the use of liquid air. 1200 w. *Glückauf*—July 8, 1899. No. 28756 B.

Electricity.

Electricity in Coal Mining—John Price Jackson and Frank F. Thompson. Presented at Boston meeting of the Am. Inst. of Elec. Eng. Refers especially to the mining of soft coal, considering systems for lighting, haulage, cutting or drilling, pumping, and driving fans. 3000 w. *Elec*, N. Y.—July 12, 1899.—No. 28561.

Firedamp.

The Testing Gallery at the Maria Coal Mine at Höngen (*Die Versuchsstrecke auf der Steinkohlengrube Maria bei Höngen*). An illustrated account of the plant at Höngen, in the Aachen district, for testing the explosive character of mine gases. 1500 w. 1 plate. *Glückauf*—July 1, 1899. No. 28755 B.

Haulage.

Modern Mine Haulage Practice. Harry K. Myers. Describes the most modern methods used in the coal mines of the United States, illustrating various mining locomotives. 4000 w. *Pro Engs' Club of Phila*—July, 1899. No. 28824 D.

Head Frames.

Steel Head Frames for Mines. George S. Binckley. Illustrates types of frames, pointing out their defects, and describing designs based on correct principles. 2800 w. *Min & Sci Pr*—July 22, 1899. No. 28828.

Hoist.

Combined Gravity and Power Hoist. A. W. Evans. A description of a unique plant for transporting coal at the mines of the New Soddy Coal Company. Ill. 2000 w. Mines & Min—July, 1899. No. 28502 C.

Mine Fires.

Extinguishing Mine Fires. Frank Pardee. Describes two successful methods employed in dealing with mine fires in anthracite coal mines. 1600 w. Mines & Min—July, 1899. No. 28504 C.

Mine Fire. H. Burrell. Describes successful methods employed in extinguishing an underground fire at Diamondville, Wyoming. 800 w. Mines & Min—July, 1899. No. 28505 C.

Pumping.

Pumping Machinery. R. S. B. On the necessity of some system of surveillance over the operation and working of mining plants, especially the pumping arrangements. 1300 w. Col Guard—June 23, 1899. No. 28437 A.

Pumps.

Pumps for Prospectors and Small Mines. F. W. Van Ness. States the conditions required in such pumps, and briefly discusses some on the market. 800 w. Eng & Min Jour—July 8, 1899. No. 28527.

Shaft.

Repairing the Lining of Shaft No. 1 of the Gneisenau Mine at Derne (Reparatur der Cuvelage des Schachtes I der Zeche Gneisenau dei Derne). F. Schulte. Describing the manner in which the cast-iron lining of the shaft was reinforced by an inner lining for a portion of its length. 1500 w. 1 plate. Glückauf—June 17, 1899. No. 28753 B.

Shot Firing.

Progress in the Electric Firing of Mine Shots. From a communication by Bergassessor Heise to *Glückauf*. Gives an idea of the progress made by electric ignition during the last two years, illustrating and describing apparatus. 3500 w. Col Guard—July 7, 1899. No. 28630 A.

Sweden.

Mining Practice in Sweden (Ueber Schwedische Bergbaubetriebe). Josef Mauerhofer. Describing especially the methods employed in mining and handling the iron ores of Northern Sweden. Serial. Part I. 2500 w. 1 plate. Oesterr Zeitschr f Berg u Hüttenwesen—July 1, 1899. No. 28752 B.

Tubbing.

Description of Tubbing Shafts Against Water. R. Clive. Prize essay of the British Soc. of Min. Students. An illus-

trated description of the tubbing of two shafts and the method of putting it in. 2000 w. Ir & Coal Trds Rev—July 7, 1899. No. 28632 A.

Ventilation.

Forced Ventilation Plants (Ueber Blasend Wirkende Hauptventilator-Anlagen). A discussion, by Bergassessor Kette, of the relative merits of forced and exhaust ventilation for mines. The use of underground blowers to force the air out of the mine, is advocated. 4500 w. Glückauf—June 24, 1899. No. 28754 B.

Winding.

An Endless Chain Winding Plant. T. A. O'Donahue. Read before the South Wales Inst. of Engs. Describes the method of winding at Rowley Colliery, and discusses the advantages. Ill. 1700 w. Col. Guard—June 30, 1899. No. 28554 A.

MISCELLANY.**Calciner.**

The Latest Type of Mechanical Calciner. W. Blackmore. Describes the Godfrey mechanical calciner, giving a vertical section, and a report of cost as compared with other methods. 1800 w. Col Guard—June 30, 1899. No. 28553 A.

Diamonds.

The Diamond Fields of Brazil. Extracts from the U. S. Cons. Rept. of Minister Bryan, describing the various kinds of diamond mining. 2500 w. Stone—July, 1899. No. 28822 C.

Mica.

The Occurrence of Mica in South Norway. J. F. Wells. Read before the Inst. of Min. & Met. Describes the mine and the deposit. Ill. 1500 w. Col Guard—July 7, 1899. No. 28631 A.

Minerals.

Feldspars and Kaolins of Southeastern Pennsylvania. T. C. Hopkins. Information based on field work, describing the mode of occurrence, method of quarrying, uses, origin, etc. 9500 w. Jour Fr Inst—July, 1899. No. 28484 D.

Petroleum.

The Fire Danger from Petroleum (Ueber die Feuergefährlichkeit des Petroleums). E. Priwoznik. A discussion of the safe fire-tests for various petroleum, giving the practice in different countries, and the statutes regulating the subject in Austria. Two articles, 3000 w. Oesterr Zeitschr f Berg u Hüttenwesen—June 24, July 1, 1899. No. 28751 each B.

Porto Rico.

Porto Rico. Manuel Victor Domenech. Describes the physical characteristics of the country and gives what is known of the undeveloped mineral deposits, which

promise to be valuable. 4000 w. Mines & Min—July, 1899. No. 28501 C.

Quarrying.

The Bluestone Industry of New York. James B. Gordon. Remarks on the changes in recent years, which led to the quarrying of thicker and larger stones, and necessary changes in methods, with an illustrated description of quarries and account of the deposits in New York State. 3400 w. Stone—July, 1899. No. 28821 C.

Riot.

The Cœur d'Alene Riot. An explana-

tion of the troubles at Kellogg, Idaho, which resulted in the blowing up of the Bunker Hill and Sullivan concentrator. Ill. 1200 w. Mines & Min—July, 1899. No. 28507 C.

Zinc Extraction.

The Electrolytic Methods of Zinc Extraction. John B. C. Kershaw. Gives a summary of the processes which have received or are now receiving industrial trial, with opinions relative to the economic aspects. 1700 w. Elec Rev, Lond—July 7, 1899. Serial. 1st part. No. 28619 A.

RAILWAY AFFAIRS

CONDUCTING TRANSPORTATION.

Accidents.

Comparative Notes on the Statistics of Accidents (*Vergleichende Betrachtungen zur Unfallstatistik*). A discussion by Herr Blum of the statistics of railway accidents in Prussia for 1897, plotted in comparative curves with those of other European railways. 4500 w. Glaser's Annalen—June 15, 1899. No. 28737 D.

Train Accidents in the United States in May. Detailed list with classified summary and remarks. 4400 w. R R Gaz—July 14, 1899. No. 28583.

Australian Railways.

Government Ownership of Railways in Australia. Extract from the *Seattle Post-Intelligencer*. Information given by a citizen of Sydney, N. S. W., very unfavorable to government operation. 1400 w. Ry & Engr Rev—July 1, 1899. No. 28470.

Master Mechanics' Association.

Meeting of the American Railway Master Mechanics' Association. A general report of the meeting, topical discussions, etc. 11700 w. R R Gaz—June 30, 1899. No. 28415.

Rules.

The Standard Code on the New York, New Haven & Hartford. Comments on the new rules just put in use on all of the 20 divisions of this road. 2000 w. R R Gaz—July 14, 1899. No. 28580.

LEGAL.

Connecticut.

Railroad Interests in the Connecticut Legislature. Clarence Deming. A statement of legislation affecting the steam and trolley interests in the state. 2500 w. R R Gaz—July 28, 1899. No. 28844.

MOTIVE POWER AND EQUIPMENT.

Air Brakes.

The Effect of the Air Brake Decision. Editorial discussing the decision in the

case of the Westinghouse Air Brake Co. against the New York Air Brake Co. 2000 w. R R Gaz—July 28, 1899. No. 28849.

Car Lighting.

Lighting Railway Carriages by Electricity. Describes and illustrates Stone's apparatus as applied to the Metropolitan railway carriages. 2200 w. Engr, Lond—July 14, 1899. No. 28801 A.

Coal Cars.

New 100,000 Lbs. Capacity Coal Cars of the Norfolk & Western. Illustrates and describes an interesting hopper bottom coal car with a steel underframe. 800 w. R R Gaz—July 28, 1899. No. 28845.

Couplers.

Automatic Couplers on American Freight Cars. Reviews the history, development and present conditions of automatic couplings in the United States. Ill. 3500 w. Engr, Lond—July 7, 1899. Serial. 1st part. No. 28633 A.

The M. C. B. Coupler. The committee report to the Master Car Builders' Assn., proposing new contour lines and new specifications. Ill. 7800 w. R R Car Jour—July, 1899. No. 28491.

English Cars.

Large Capacity English Cars. Detail drawings of a 50-ton capacity goods wagon for iron ore service on the Caledonian Railway. 300 w. Ry Age—July 21, 1899. No. 28692.

Fire Box.

See Mechanical Engineering, Steam Engineering.

Firing.

Economical Locomotive Firing. K. P. Alexander. Abstract of paper prepared for the St. Louis Ry. Club. Suggestions to promote economy, advising a traveling

engineer competent to instruct the firemen. 900 w. Ry & Engng Rev—July 8, 1899. No. 28535.

Indicator Cards.

Locating the Cut-Off and Other Events on Locomotive Indicator Cards. C. H. Robertson. Illustrates and describes the practice of the author in locating points named. 1500 w. R R Gaz—June 30, 1899. No. 28416.

Locomotive Boilers.

Locomotive Boilers—Some Points to Be Thought of When Getting Them. H. Wade Hibbard. Discussing recent designs of boilers and boiler-shop methods. Followed by general discussion. 12000 w. N. Y. R R Club—May 18, 1899. No. 28608.

Locomotives.

American Locomotives for the Midland Railway. Drawings and dimensions of these engines, with statement of the conditions stipulated. 800 w. Engng—July 7, 1899. No. 28625 A.

Atlantic Type Locomotive—Class E-1, No. 698. Illustrated description with dimensions of an unusually interesting engine built for the West Jersey and Seashore Div. of the Pennsylvania Railroad. 600 w. R R Gaz—July 7, 1899. No. 28497.

English and American Locomotive Building. Charles Rous-Marten. Mr. Rous-Marten's second paper contains a comparison of the salient differences in design and construction between English and American engines, and numerous views in English and American works. 5000 w. Engineering Magazine—August, 1899. No. 28784 B.

Fast Passenger Locomotives on the Pennsylvania Railroad in 1850. Illustrates and describes three locomotives of the "Crampton" type. 1300 w. R R Gaz—July 28, 1899. No. 28850.

Goods Engine, Furness Railway. Illustrations showing sections and a general external view of this six-wheeled coupled goods engine, with dimensions. 500 w. Engr, Lond—July 7, 1899. No. 28635 A.

Handling the Richmond Compound. Robert Rennie. Calls attention to the operation of the valves and the care and lubrication needed. 1200 w. Loc Engng—July, 1899. No. 28410 C.

Heavy Freight Locomotives for the Lehigh Valley R. R. Illustrated detailed description, giving dimensions. 1000 w. Eng News—July 27, 1899. No. 28833.

Pennsylvania Railroad Class H-6 Locomotives. An outline in detail of the new features of these engines, with drawings and dimensions. 600 w. R R Gaz—July 14, 1899. No. 28581.

Schenectady Consolidation Locomotives for the D. & H. Engraving and descriptive specifications. 350 w. R R Gaz—July 28, 1899. No. 28848.

60-Ton Heisler Geared Locomotive: McCloud River R. R., Northern California. Particulars of an engine having three driving trucks, or twelve driving wheels, which has been in service some time. 900 w. Eng News—July 27, 1899. No. 28835.

Ten-Wheel Passenger Locomotives for the Denver and Rio Grande R. R. Illustration and principal dimensions. 500 w. R R Gaz—July 28, 1899. No. 28847.

The First Engines Built at Crewe. Clement E. Stratton. An account of engines completed in 1842, with interesting information relating to them. 1800 w. Mech Wld—July 7, 1899. No. 28646 A.

Passenger Coach.

Metal-Plating for Passenger Coach. Illustrates and describes a car in which each piece of wood is covered with sheet copper in such a manner that the metal fits into and around the conformations. 500 w. Ry & Engng Rev—July 22, 1899. No. 28693.

Rolling Stock.

The Rolling Stock of the Great Central Railway, England. The first of a series of illustrations and detailed descriptions of the accommodations for passenger traffic. The present article is merely a brief introduction, with illustrations of elevation and under frame plan. 250 w. Engng—July 14, 1899. Serial. 1st part. No. 28695 A.

Stay Bolts.

See Mechanical Engineering, Steam Engineering.

NEW PROJECTS.

Railroad Changes.

The Boston and Albany and the Central. Editorial comment on the agreement by which the B. & A. passes into the ownership and control of the N. Y. Central. 1200 w. R R Gaz—July 7, 1899. No. 28499.

Railway Development.

The World's Railways and Iron and Steel Requirements. Part first discusses the railway prospects of Africa, giving maps. 2800 w. Ir & Coal Trds Rev—June 30, 1899. Serial. 1st part. No. 28548 A.

South America.

An American Railway in Colombia. Francis R. Hart. Gives a brief outline of the history of Colombia and the physical characteristics of the country and describes the terminal works, railway, and line of steamboats owned and managed

by an American corporation. Ill. 4300 w. Tech Quar—June, 1899. No. 28521 E.

Tehuantepec Railway.

The Tehuantepec Railway Across the Isthmus of Mexico. Reviews the history of the road and the work to be done before it is opened for traffic. 1200 w. Transport—July 14, 1899. No. 28688.

PERMANENT WAY AND FIXTURES.

Boston Station.

The Boston Southern Station. J. P. Coleman. Continuation of an article published May 12. The present article describes the electro-pneumatic interlocking, giving diagram of switches and signals, and general views. 2700 w. R R Gaz—July 21, 1899. No. 28670.

Coal Dock.

Coal Dock Plant of the Baltimore and Ohio Ry., Sandusky, Ohio. A description of the plant and its operation. Ill. 700 w. Ry & Engng Rev—July 1, 1899. No. 28469.

Earth-Slips.

Causes of Earth-Slips in the Slopes of Cuttings and Embankments of Railways, and How to Prevent or Remedy Them. Robert Elliott. Read before the Engng. Conference of the Inst. of Civ. Engs., England. A brief consideration of the topics named. 1600 w. Engr, Lond—June 23, 1899. No. 28433 A.

Gage Widening.

Change of Gage on the Columbia and Western Ry. An account of the work of widening the gage without interrupting traffic. 700 w. Ry & Engng Rev—July 15, 1899. No. 28614.

Klondike.

See Mining and Metallurgy, Gold.

Paris.

The Extension Works of the Station of the Eastern Railway of France (Les Travaux d'Aggrandissement de la Gare de l'Est). G. Leugny. With plans and views of the extension works now in progress in view of the increased travel anticipated during the Paris Exposition. 2000 w. Revue Technique—July 10, 1899. No. 28709 D.

The New Lines of the Western Railway of France (Les Nouvelles Lignes de la Compagnie des Chemins de Fer de l'Ouest). A description of the new connections made by the absorption of some local railways by the Western Railway of France together with the new construction work now in hand in and about Paris. 3500 w. Rev Gen des Chemins de Fer—June, 1899. No. 28717 G.

The Prolongation of the Orleans Railway in Paris (Le Prolongement de la

Ligne d'Orleans dans Paris). E. Dieu-donné. With numerous views of the present state of the work from the Place Vallmbert to the Quai d'Orsay, and a plan of the new terminal station. 4000 w. 1 plate. Revue Technique—June 25, 1899. No. 28706 D.

Railroad Stores.

A New Method of Keeping Track of Railroad Stores. Explains the method used by the Illinois Central Railroad at the Burnside shops, Chicago. 1000 w. Ry & Engng Rev—July 8, 1899. No. 28534.

Relaying Railways.

The Most Expeditious Method of Relaying the Railways of This Country, Involving the Least Interruption of Traffic, Having Regard to Safety and Economy. Harry Footner. Read before the Engng. Conference of the Inst. of Civ. Engs., England. Classifies and discusses methods. 1400 w. Engr, Lond—June 23, 1899. No. 28432 A.

Shed Extension.

Moving a Great Steel Arch. Illustrates and describes the work of moving a pair of steel arches weighing 300 tons, in the shed extension of the Pennsylvania Railroad depot in Jersey City. 700 w. Ir Age—July 20, 1899. No. 28653.

Signals.

The Bouré Locking System (Les Sur-rures d'Enclenchement du Système Bouré). M. A. Moutier. A very complete account of the Bouré system of locks and keys for the prevention of tampering with railway signals, as employed on the Northern Railway of France. 20,000 w. Rev Gen des Chemins de Fer—June, 1899. No. 28718 G.

Sleepers.

Comparative Trials on Metallic Sleepers (Essais Comparatifs de Traverses Metalliques). Ch. Renson. A review of the results obtained with various types of metallic cross-ties on the Liège-Limburg Railway between 1881 and 1898. Two articles, 6000 w. Schweizerische Bauzeitung—June 10, 17, 1899. No. 28742 each B.

Station.

The New Railway Station at Tours (La Nouvelle Gare de Tours). A fully illustrated account of this handsome new French railway station, with plan of the approaches, and details of the construction. 2500 w. 1 plate. Génie Civil—June 24, 1899. No. 28702 D.

Telephones.

The Telephone in Railroad Service. George W. Blodgett. Considers requirements for sending important railroad

messages by telephone. 1500 w. R R Gaz—July 28, 1899. No. 28846.

Terminal.

Southern Pacific Terminal at Oakland. Illustrates and describes the recently re-arranged and improved station. 600 w. R R Gaz—July 21, 1899. No. 28672.

Tunnel Ventilation.

The Ventilation of the St. Gothard Tunnel. At first natural ventilation of this tunnel proved sufficient, but increased traffic made necessary artificial ventilation. The means adopted to secure the desired results are here described. 1000 w. Engng—June 30, 1899. No. 28551 A.

The Ventilation Plant for the St. Gothard Tunnel (Ventilations-Anlage für den Gotthard-Tunnel). A description of the Saccardo ventilating system as installed at Göschenen for forcing air through the St. Gothard tunnel. 3500 w. Schweizerische Bauzeitung—June 17, 1899. No. 28744 B.

Ventilation of the St. Gothard Tunnel. Editorial on the condition of the air in this tunnel, and the means recently adopted to effect a change of air, which

has thus far proved effective. 1000 w. R R Gaz—July 14, 1899. No. 28582.

TRAFFIC.

Freight.

The Right to Route Your Freight. Editorial on an interesting decision of the Supreme Court of Tennessee. 3500 w. R R Gaz—June 30, 1899. No. 28417.

Railway Statistics.

Statistics of Railways in the United States for the year ending June 30, 1898. Advance abstract of the forthcoming Interstate Commerce Commission report. 900 w. Eng News—July 20, 1899. No. 28676.

Rates.

The Texas Railway Commission and Railway Rate Discriminations. Editorial discussion of the revelations brought out by the railway commission of Texas in regard to free transportation, rebates, etc. 1700 w. Eng News—July 6, 1899. No. 28456.

The Ton-Mile Rate and a Great Consolidation. Editorial discussion of the principles affecting rate averages, considering the ton-mile average from the point of view of the railroad stockholder. 2000 w. R R Gaz—July 21, 1899. No. 28673.

STREET AND ELECTRIC TRAMWAYS

Accumulators.

Accumulator Driving on the Electric Street-Railway in Ghent (Akkumulator-enbetrieb der Elektrischen Strassenbahn zu Ghent). J. Zacharias. With a general description of the method of charging the batteries, and details of the working of the plant. There are 38 motor cars and 22 miles of track. 1500 w. Elektrotech Zeitschr—July 6, 1899. No. 28769 B.

Boosters.

Boosters in Street Railway Service. M. C. Canfield. Explains what a booster is and its use. 1600 w. Engr, U. S. A.—July 1, 1899. No. 28466.

Boston Elevated.

Building the Boston Elevated. Edgar M. Smith. Views showing details of foundation work on the Charlestown Division are given, and the difficulties are explained. 1300 w. R R Gaz—July 7, 1899. No. 28498.

The Feeder System of the Boston Elevated Railway. H. W. Weller. An illustrated description of the system and matters connected with it, with some of the methods adopted to obtain the most economical results. 3800 w. Ry Wld—July 6, 1899. No. 28664 A.

Brazil.

The New Railway, Light and Power Enterprise in Sao Paulo, Brazil. Brief illustrated description, with information of this city directly under the tropic of Capricorn. 1400 w. St Ry Jour—July, 1899. No. 28479 D.

Cairo.

The Cairo Electric Tramways. Illustrated description of the line and its equipment, with views on the route. 900 w. Ry Wld—July 6, 1899. No. 28665 A.

Corea.

The Electric Railway in Seoul. An interesting illustrated account of the opening of an electric railway in the capital of Corea. 800 w. Ry Age—July 21, 1899. No. 28691.

Düsseldorf.

The Electric Light-Railway Between Düsseldorf and Krefeld. Abbreviation of a paper by Gustav Braun, published in the *Elektrotechnische Zeitschrift*. An illustrated detailed description of a railway of interest on account of its high-speed working, and the deviation from ordinary practice in its construction. 2800 w. Elec Eng, Lond—July 7, 1899. Serial. 1st part. No. 28643 A.

The Electric Railway Between Düsseldorf and Krefeld (*Die Elektrische Kleinbahn Düsseldorf-Krefeld*). Gustav Braun. A fully illustrated description of this recently opened road, which passes over the new Rhine bridge at Düsseldorf, and which is used both for passenger and merchandise. 7000 w. *Elektrotech Zeitschr*—June 22, 1899. No. 28760 B.

Electric Traction.

Electric Traction on Tramways. J. Clifton Robinson. Extracts from paper read before Cleveland Inst. of Civ. Eng. at Stockton-on-Tees, England. Relates to the tramways of Bristol, Dublin, Middlesborough, Stockton and Thornaby, and the London United tramways. 5000 w. *St Ry Jour*—July, 1899. No. 28482 D.

Electrolysis.

Electrolysis at Yonkers, N. Y. Information from report of A. A. Knudson. Describes the serious condition of the water mains, detected by electric measurements. 500 w. *Eng Rec*—July 1, 1899. No. 28446.

Granite Tramways.

The Heytor Granite Tramway. W. B. Paley. An account of a unique railroad in the west of England, built in 1820 by a private individual. 900 w. *R R Gaz*—July 21, 1899. No. 28671.

Hull.

The Hull Electrical Tramways. Historical account and illustrated description. 3800 w. *Elec Rev, Lond*—July 7, 1899. No. 28617 A.

Hungary.

The Light Railways of Hungary in 1897 (*Die Ungarischen Kleinbahnen in Jahre, 1897*). Rudolf Nagel. A tabulated review of street and electric tramways and light suburban railways, giving the traffic earnings, and operative data. 2000 w. *Glaser's Annalen*—No. 28741 D.

Kingston.

The Street Railway System of Kingston, Jamaica. Henry E. Raymond. Illustrates and describes an example of high grade hydraulic and electric engineering in the West Indies. 2000 w. *Am Elect'n*—July, 1899. No. 28493.

Louisville, Ky.

Power Station and Shops of the Louisville Railway Co. Illustrates and describes the electrical repair shop and its branches, also the power house. 1400 w. *St Ry Jour*—July 15, 1899. No. 28667 C.

Multiple-Unit System.

The Problem of Elevated and Suburban Electric Railway Transportation. Frank J. Sprague. Abstract of a lecture read before the Am. Inst. of Elec. Eng. Sets forth the advantages of the multiple unit system, giving results on the South-side Elevated of Chicago. Also an interesting chronology of modern electric railroad operation. 10500 w. *St Ry Jour*—July, 1899. No. 28481 D.

Municipal Ownership.

Decision in the Detroit Case. Text of the decision of the Supreme Court of Michigan holding the law providing for municipal ownership of Detroit street railways to be unconstitutional. 8000 w. *St Ry Rev*—July 15, 1899. No. 28669 C.

Niagara Gorge.

Building the Niagara Gorge Railway. George A. Ricker. An account of the business side of the enterprise, with illustrations of the route, and description of the construction. 5500 w. *Pro Eng's Club of Phila*—July, 1899. No. 28826 D.

Overhead.

Overhead Construction for Electric Tramways (*Oberleitungsmaterial für Elektrische Bahnen*). A general description of the connections, insulators, supports, and details of overhead trolley construction as used by the *Allgemeinen Elektrizitätsgesellschaft* of Berlin. 5000 w. *Elektrotech Zeitschr*—July 13, 1899. No. 28770 B.

Pittsburg Tramways.

System of the United Traction Company, Pittsburg. Illustrated detailed description of the consolidated roads and their equipment. 3000 w. *St Ry Jour*—July, 1899. No. 28477 D.

Power Station.

Power Station of the Northwestern Elevated Railway of Chicago. Illustrates and describes a plant nearing completion. 1400 w. *St Ry Jour*—July, 1899. No. 28480 D.

Shops.

Shops of the Consolidated Traction Co., Pittsburg, Pa. Illustrated detailed description of finely equipped shops. 3400 w. *St Ry Rev*—July 15, 1899. No. 28668 C.

Track Construction.

Track Construction of the Cincinnati Street Railway Company. A report on the construction that has had five years' wear, and changes made in power. Ill. 1200 w. *St Ry Jour*—July, 1899. No. 28478 D.

NEW CATALOGUES AND TRADE PUBLICATIONS

*These catalogues may be had free of charge on application to the firms issuing them.
Please mention The Engineering Magazine when you write.*

Cole, Marchent & Morley, Bradford, England.—Illustrated catalogue of steam engines and condensing plant, describing the construction in detail. A well got-up booklet. Useful information for engineers is also given.

Humpidge, Holborow & Co., Ltd., Dudbridge Iron Works, Stroud, Glos., England—(a) Illustrated price list of the "Dudbridge" gas engine with large number of testimonials from users; (b) Price list of Dudbridge oil engines with statement of advantages claimed.

The British Bundy Co., 81, Southwark St., London, S. E.—(a) Pamphlet entitled "Leaks," showing the economies to be effected by the use of the Bundy Time Recorder; (b) List of users of the Bundy Recorder; (c) Testimonials from users. All these pamphlets are got up in a very artistic style.

A. A. Rickaby, Bloomfield Engine Works, Monkwearmouth, Sunderland, England.—Price list of engineers' supplies, packings, piston rings, etc.

P. & W. MacLellan, Ltd., 129, Trongate, Glasgow, Scotland.—Catalogue (Section I.) embracing machinery for lifting weights by hand, steam, electric, or hydraulic power; and illustrating and describing such appliances from a pulley block to a locomotive, winding engine or heavy crane. Portable railways and heavy rolling stock are also included.

The Harrisburg Foundry and Machine Works, Harrisburg, Pa., U. S. A.—Handsome catalogue describing the system of steam engines made by the concern, as well as other products, including boilers, furnaces and road-rollers. A copy of the *edition de luxe* of the same catalogue has also been received, handsomely bound and ornamented, for special distribution.

The Chisholm & Moore Manufacturing Co., Cleveland, Ohio, U. S. A.—Catalogue of chain hoists operated by pneumatic, electric, and hand power, also of pneumatic cranes, and of trolleys for use with chain hoists.

The Winslow Bros. Co., Chicago, Ill., U. S. A.—Portfolio catalogue containing reproductions of bronze decorative work, including gates, mausoleum doors, panels, tablets, etc., the whole forming a remarkably handsome collection both as regards the original subjects and the manner of their presentation.

Baldwin Locomotive Works, Philadelphia, Pa., U. S. A.—Record of recent construction, No. 13, containing numerous valuable diagrams for the determination of piston speeds, tractive power, speed resistance, hauling capacity, etc., together with the formulas from which the diagrams have been constructed and instructions as to their use. The whole forms a valuable collection of information having the practical endorsement of the firm by which it is issued.

P. R. Jackson & Co., Ltd., Manchester, England.—Complete catalogue, listing a large line of steel castings and forgings, moulded gears, etc.; also electrical equipment, such as motors, dynamos, electric hauling, winding and pumping plants for mines, arc lamps, etc. Fully illustrated with views of works. A very valuable catalogue.

The Kingfisher Patent Manufacturing Co., Leeds, England.—Series of price lists of lubricants, anti-fouling compositions, boiler liquors, etc.

John Langfield & Co., 11, Blackfriars St., Manchester.—Pamphlet describing Langfield's "Moist Air" heating and ventilating apparatus, with list of users. Illustrated.

The Rankine Patent Feed Water Filters Co., Ltd., Victoria St., London.—Circulars describing feed water filters of various types. A type of filter with double filtration is also described. Illustrated.

Isaac Storey & Sons, Manchester, England.—(a) Series of sheets, pricing gun metal fittings, gauges, valves, lubricators, etc.; (b) catalogue of Proell's automatic expansion apparatus, the Proell Corliss engine, and Proell's spring governor. Full particulars; (c) Pamphlet entitled "Shall We Use Proell's Automatic Expansion Apparatus?"

John Lang & Sons, Johnstone, Glasgow, Scotland.—Lathe catalogue describing all types in general use; also gear cutting machines and other tools. Fully illustrated.

Merchant & Co., Philadelphia, Pa., U. S. A.—Small pamphlet describing the improved method of dipping tin plate adopted by the firm for the purpose of insuring a uniform thickness of tin coating over the entire surface.

Fraser & Chalmers, Chicago, Ill., U. S. A.—Catalogue No. 3, Fourth Edition, devoted to methods and machinery for roasting, smelting, and refining, for gold, silver, lead, and copper. Numerous illustrations and plans of standard appliances are given, together with useful information as to methods of work.

The Snider-Hughes Co., Cleveland, Ohio, U. S. A.—General Catalogue No. 11, of steam pumps, high-duty pumping engines, hydraulic machinery, air compressors, and air-lift plants; with illustrations and specifications of the different machines, and a number of useful tables of the properties of water and steam.

Webster, Michelson & Co., Eve Hill Works, Dudley, England.—Circular describing and pricing dynamos and copper gauze brushes.

T. W. Palmer & Co., 5, Victoria St., London, S. W.—Price list of steel wire fencing of various kinds; galvanized netting; continuous iron corrugated rail fencing, etc. Wrought iron entrance gates are also illustrated and priced, as well as corrugated iron buildings.

United Flexible Metallic Tubing Co., 112, Queen Victoria St., London.—Circular price list of flexible metallic tubing.

The Electrical Co., Ltd., Charing Cross Road, London, W. C.—Series of illustrated catalogues and price lists of (a) Dynamos and electric motors; (b) Luna arc lamps and accessories; (c) Switches and wall plugs; (d) Knife switches; (e) Lamp Holders; (f) Accumulator apparatus; (g) Measuring and testing instruments; (h) Ceiling roses, fuse wire, etc.; (i) Carbons for arc lamps; (k) Incandescent lamps; (l) Heating and cooking apparatus.

Geo. Richards & Co., Ltd., Broadheath, near Manchester, England.—Illustrated catalogue (a) of pulleys, hangers, shafting couplings and other mill fittings; (b) Wood working machinery with particulars of a full line of tools. Prices are given.

The McConway & Torley Co., Pittsburgh, Pa., U. S. A.—Handsomely bound catalogue of the Janney coupler, for passenger cars, freight cars, and locomotives. Plates of all the various parts are given, together with lists of pieces by number, and a very complete index, rendering the catalogue most valuable for reference.

The Ball Bearing Co., Boston, Mass., U. S. A.—Catalogue of ball and roller bearings for all kinds of machine construction, shafting and vehicles, with price lists and telegraph codes.

The Barber Asphalt Paving Co., New York.—Descriptive catalogue of genuine Trinidad lake asphalt pavements, with many illustrations of asphalt paved streets in various cities, together with maps and lists of streets in the principal cities of the United States, showing the extent to which asphalt pavements have been introduced.

New York Central and Hudson River Railroad, New York.—Four Track Series, No. 10. Pamphlet descriptive of the attractions of the Thousand Islands and the St. Lawrence river, with map and much general information.

The British Luxfer Prism Syndicate, Ltd., 16, Hill St., Finsbury, London.—(a) Illustrated manual of "Luxfer Prisms" and Electric Glass, being a short treatise on the introduction of light to buildings by the aid of this device. The information is of considerable interest; (b) Pamphlet entitled "Fire-Resisting Window Glass," which states the advantages of Electro-glass.

Thomas Larnuth & Co., Salford, Manchester, England.—Catalogue of the "Hirnant" mining machinery, giving particulars of air compressors, rock drills and other mining plant; a description of a shaft sinking carriage is also given. Fully illustrated, also prices.

Victor Coates & Co., Ltd., Lagan Foundry, Belfast, Ireland.—(a) Illustrated catalogue of Engines, boilers and cranes, with prices and code for ordering. Particulars of machinery for the tobacco, malting and other trades are also given; (b) Abridged edition of the above catalogue.

Samuel Denison & Son, Hunslet Foundry, Leeds, England.—Catalogue of scales, weighing

machines and weighbridges, with prices and illustrations. Two new wire testing machines for fine wire are also illustrated.

Charles E. Billin & Co., Chicago, Ill., U. S. A.—General catalogue of machinery and supplies for mines and mills, being pages 485 to 572 of the general serial catalogue issued by this firm, and containing, in addition to the goods listed, extracts from various sources of information in regard to mining machinery and appliances.

Electric Storage Battery Co., Philadelphia, Pa., U. S. A.—Illustrated pamphlet describing the installation of chloride accumulators in the criminal court building, New York City; with diagram showing the manner in which the battery assists in equalizing the load upon the engine.

The Bullock Electric Co., Cincinnati, Ohio, U. S. A.—Handsomely illustrated catalogue of Bullock electric generators and motors, with examples of numerous applications of electric driving by direct connection to various machine tools and other machinery.

Rand Drill Co., New York.—Advance sheets of 1899 catalogue, illustrating and describing air and gas compressors, with many illustrations of existing installations, and tabulated information concerning numerous styles and sizes of compressors.

Latch & Batchelor, Ltd., Hay Mills, Birmingham, England.—Circular describing and showing sections of "flattened strand" wire ropes, with list of sizes and breaking strains.

Schattner & Co., Timberhill, Norwich, England.—Circular describing the "Long Schattner" prepayment meter for electricity.

W. N. Brunton & Son, Wire Works, Musselburgh, Scotland.—Price list of wire, with breaking strains and other data; also of springs of coppered steel, and galvanized and tinned iron work.

E. & J. Richardson, Elswick Leather Works, Newcastle-on-Tyne, England.—Price list of leather belting.

The Campbell Gas Engine Co., Ltd., Halifax, England.—Catalogue of the Campbell oil engine and ram pumps; also long list of testimonials from users. Fully illustrated.

Flather & Son, Park Electrical Works, Leeds.—Price list of continuous current dynamos and motors of the multipolar type.

Waterbury Rope Co., New York.—Pamphlet catalogue about rope and rope-making, with especial reference to rope for transmission and hoisting. An account of the gathering of the material and processes of manufacture is given, together with useful information concerning weights and strength of various sizes.

Pittsburgh Feed-Water Heater Co., Pittsburgh, Pa., U. S. A.—Catalogue of Pittsburgh feed-water heaters, both open and closed, with descriptions of the different types, and numerous testimonials from users.

Westinghouse Electric & Mfg. Co., Pittsburgh, Pa., U. S. A.—Detail catalogues (a) of the West-

inghouse direct-current fan motor; (b) of the Westinghouse alternating-current fan motors; and (c) of the Wurts non-arcing lightning arresters.

The Winton Motor Carriage Co., Cleveland, Ohio, U. S. A.—Neat pamphlet containing an account of the recent trip of a Winton motor carriage from Cleveland to New York, a distance of more than 700 miles. An illustrated description and price-list of the various types of Winton vehicles is appended.

The Edison & Swan United Electric Light Co., Ltd., 36, Queen Street, London, E. C.—Illustrated catalogues as follows: Sections 1 and 2, Incandescent Lamps. Section III., Electric light fittings of all descriptions. Section IV., Fittings, (Supplementary list). Section VII., Dynamos, alternators, transformers, etc. Section IX., Glass, silk and paper shades and globes. These sections together form a very large and complete catalogue of electric lighting requisites.

Walter Newbold & Co., 28, Gracechurch St., London, E. C.—Catalogue of machine tools, including all usual types, with prices and specifications. Fully coded.

The Crypto Works Co., Ltd., 29, Clerkenwell Road, London.—Illustrated price lists of motors and dynamos, from four candle power up.

John Davis & Son, All Saints Works, Derby, England.—Catalogue entitled "Electric Mining," giving particulars of a variety of electrical appliances and electrically driven plant as used in mines.

Miller & Co., Ltd., London Road Foundry, Edinburgh, Scotland.—Well printed Catalogue of chilled iron wheels for tramways, chilled points and crossings and other chilled iron castings. Fully illustrated; also testimonials.

The Phosphor Bronze Co., Ltd., 87, Sumner St., Southwark, London.—(a) Collection of circulars giving strength, weights, tenacity, and other particulars of the alloys which are the specialty of the company; (b) Testimonials from users of Phosphor-Bronze and "Duro" metal for rolling mills, mining machinery, marine and stationary engines, etc.

Savage & Co., Love Lane, Eastcheap, London, E. C.—Illustrated price list of grocers' machinery, such as coffee roasters, tea bins, sugar cutters, scales, etc.

Redpath & Paris, Lea Cut Ironworks, Limehouse, London.—Illustrated catalogue of High Speed Noiseless engines, with full exposition of special advantages claimed.

The Improved Electric Glow Lamp Co., Ltd., 103, Queen Victoria St., London, E. C.—Catalogues of the "Electric Glow Lamp," with prices, fully illustrated, views of the firm's works and offices being included.

Oliver & Co., 61, Wilson St., Finsbury, London, E.—Loose sheet illustrating, pricing, and describing the "Oliver" patent arc lamps.

The Cotton Powder Co., Ltd., 32, Queen Victoria St., London, E. C.—Two pamphlets, first being entitled, "Twenty Years With Tonite, as a Safe High Explosive," and the second "Socket Signals for Signaling and Distress Purposes."

Crompton & Co., Ltd., Mansion House Buildings, London, E. C.—Series of illustrated catalogues and price lists of (a) Dynamos and motors for various industrial purposes; (b) Arc lamps, projectors and lamp hoisting gear, etc.; (c) Alternators, transformers and accessories; (d) Electrical cooking and heating apparatus; (e) Electrical measuring instruments; (f) Loose sheets pricing various electrical specialties. All these lists are coded and contain full descriptions of the machines, sizes, etc.

Siebe, Gorman & Co., Westminster Bridge Road, London, S. E.—Handsome catalogue of diving apparatus, diving bells, rock drills, salvage pumps and other submarine appliances, with prices and descriptive matter. Fully illustrated in half tone.

Geo. Smith & Co., Ltd., 13, Commercial Road, Pimlico, London.—Illustrated circulars of (a) The Parkinson Saw Guard; (b) Turner's Portable Fire Engine; (c) Portable Automatic Sack Hoist.

Evershed & Vignoles, Ltd., Woodfield Works, Harrow Road, London.—Illustrated price lists of (a) Evershed ammeters and voltmeters; (b) Electric gauges; (c) Dead-beat gauges; (d) Portable testing sets. In addition to prices and sizes, information as to working and special features is included.

M. Glover & Co., Leeds, England.—Folder illustrating and describing the "Ideal" saw guard, with testimonials.

The Reliance Lubricating Oil Co., 19, Water Lane, Great Tower St., London.—Price list of lubricants and patent oil cabinets.

Holder & Brooke, Ltd., Sirius Works, West Gorton, Manchester, England.—Abridged catalogue of steam users' specialties, prominent among which are a balanced stop valve, a silent heater, and the "Sirius" pulsating pump.

The Langdon-Davies Electric Motor Co., Ltd., 101, Southwark St., London.—Illustrated catalogue of alternate current motors, with views of the firm's works.

Woodite Company, Mitcham Common, Surrey, England.—Pamphlet pricing "Woodite" packings and insulating materials, hose, washers, corks, etc.

S. E. Norris & Co., Shadwell, London, E. C.—(a) Handsomely illustrated price list of leather machine belting, pump and hydraulic leathers, etc.; (b) Price list of fire hose, leather fire buckets and gun metal fittings.

The Roller Bearings Co., Ltd., 1, Delahay St., Westminster, London.—Illustrated catalogue of roller bearings showing their application to tramways, shafting, mine fans, etc.





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